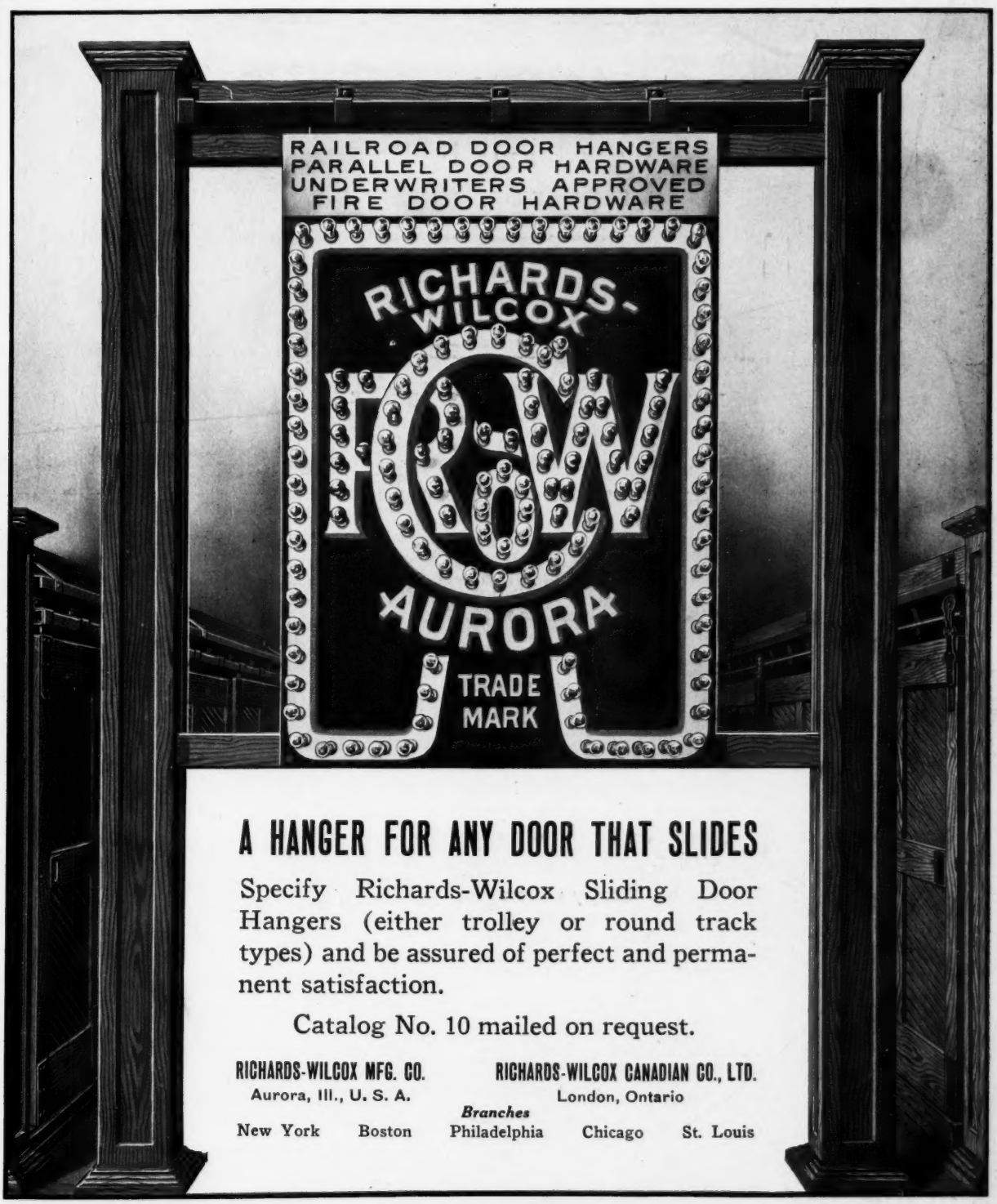
RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

BRIDGES - BUILDINGS - CONTRACTING - SIGNALING - TRACK

New Series, Vol. IX
Old Series, Vol. XXVIII | *Chicago* | APRIL, 1913 | *New York* | No. 4



A HANGER FOR ANY DOOR THAT SLIDES

Specify Richards-Wilcox Sliding Door Hangers (either trolley or round track types) and be assured of perfect and permanent satisfaction.

Catalog No. 10 mailed on request.

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It's Ever Too Late To Mend

No tool of character should need early mending.—It should be so designed and built that it will render exacting and long service under difficult conditions.

When A Man Uses Track Tools

In the design and make of our tools, we have specialized from the worker's viewpoint.

We have enabled him to perform more service for a like period, with a mind free from possible mishaps.

There are no frailties in the HUBBARD LINE. Their character and strength for performance are indisputable.

If you failed to see our exhibit at the American Railway Engineering Association's convention, and you are open to conviction, request our comprehensive catalog.

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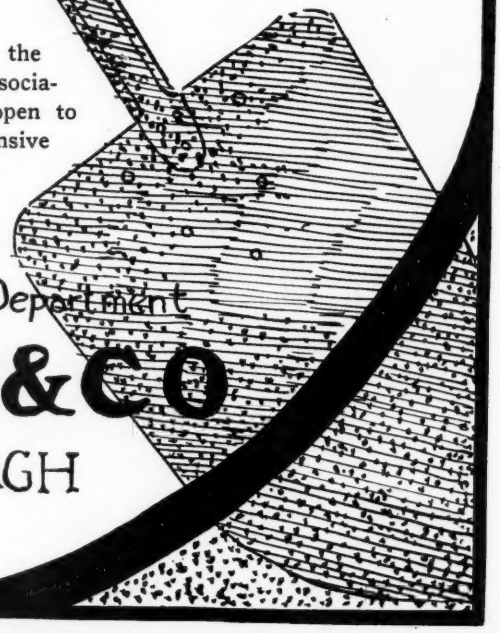
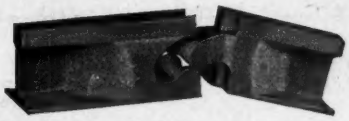
he has neither the time nor the inclination for conservation. He is out to do hard work in a given time, and expects to be equipped with dependable tools.

In no instance have HUBBARD TOOLS failed to provoke commendation from both purchaser and user.





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Interlocking Rail Joint Locked

INTERLOCKING RAIL JOINTS

Save in *Initial* cost of Laying Rails *because* there are

No Angle Bars, Bolts or Bond Wires Required

Save in *Ultimate* Cost in Greater Proportion *because* of

Longer Life of Rail—No Bolt or Angle Bar Replacements Necessary

They Eliminate Low Joints and Vibration, and Allow

Equal Expansion and Contraction at All Joints

Write for further information.

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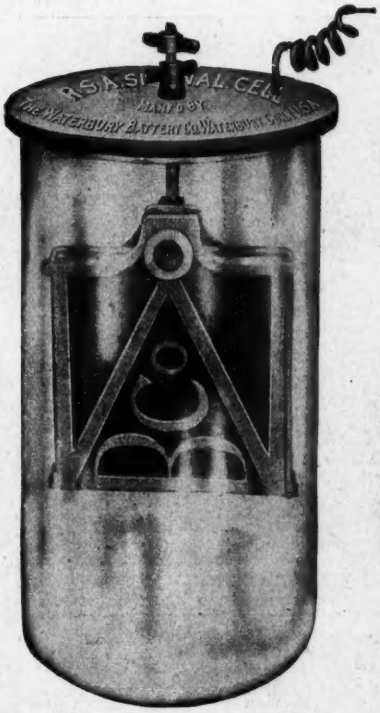

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Causes loss in track circuit currents.

You must make provision for this loss in generating your current.

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R.S.A. Battery Cells

are designed for a maximum overload. They can be depended upon to take care of emergencies.

Spring weather means trouble for the signalman but not with battery cells if you use Schoenmehls.

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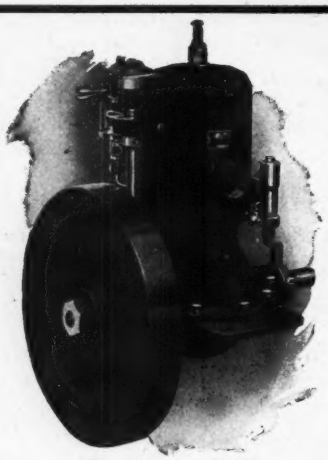

Weight 160 lbs. 4 H. P.

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Powerful—simple—reliable—two-cycle engines that will drive a car over any grade in the country and have a punch left for a head wind. It's a motor you'll be proud to own—and look at the hard work it will save you every day.

Build Your Own Motor Car

We know exactly what you need and furnish everything complete so that the installation can be made with ordinary tools.

Smaller Sizes for Velocipedes.

CONCRETE FORM & ENGINE CO.
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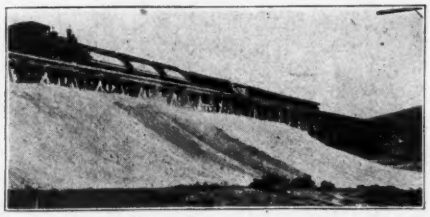
Trestle Filling, Raising Grades, Widening Road Beds

Can be economically and satisfactorily done with

Western Air Dump Cars



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They dump their loads clear, so train can pull out without any shovelling by hand. This is a big saving in time and labor.

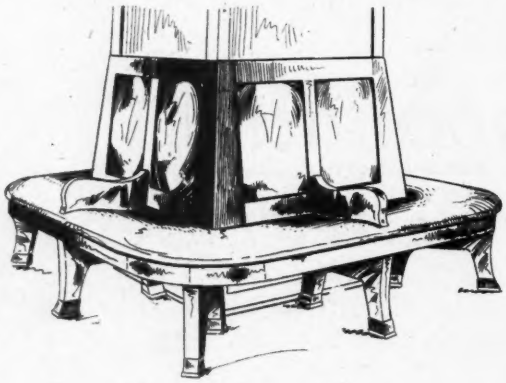
Our catalog contains many interesting facts

Write for it today

Western Wheeled Scraper Co.
AURORA, ILLINOIS
EARTH & STONE HANDLING MACHINERY

SETTEES

Standard in every respect



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The A. H. ANDREWS CO.
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40 designs in new Catalog
Special work estimated

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GASOLINE ENGINES FOR HAND CARS

***The* FAIRMONT WAY**
6 MEN, PUSH-CAR & 45 TIES HANDLED SUCCESSFULLY WITH 3 H.P. FAIRMONT ENGINE

***The* FAIRMONT ENGINE**
SAME CREW STARTING OUT TO WORK

The Fairmont Way.
Runs either way on track without turning car around.
Starts a big load without pushing the car.
Fully equipped and can be put on car in two hours and run.
Great Power—Light Weight.
We make a special car for Roadmasters' Inspection purposes.
Write today for full particulars and easy payment plan.

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Concrete Mixers are material aids for careful railroad men who

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PPOSED to one another in the Koehring, there are three independent mixing actions, designed to perform satisfying service—to really

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ACH mixing action gives its individual, yet concerted effort to cause a continual intermingling of all material in the drum, and, consequently, mixes about three times as much

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you get three times as fast mixing as with machines enjoying one action alone. Very

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the Extension Loader feature which was designed particularly for you. Call on us for names, then ask

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your authority to recommend equipment; get

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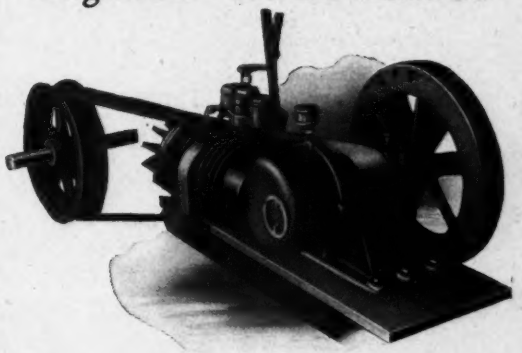
If you can make railroad construction easier, give me particulars. My road needs machinery carefully designed for quick and long performance.

Lighten Your Labor



by using the

Mudge Engine Equipment for Hand Cars

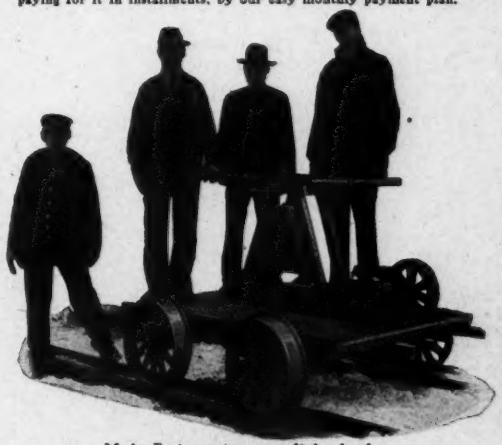
Easy to Buy—Easy to Install—Easy to Operate

The Mudge Hand Car Equipment is so simple that anyone can install it in two or three hours. No experience or special tools necessary.

This is the same 2 cycle air-cooled 4 Horse Power engine that has been in service seven years and is running successfully on hundreds of Mudge-Adams Inspection Motor Cars. Its power and durability have been proven.

The aim of the designer in getting up this engine was to make it as simple as it could possibly be and run well. The cutting off of each unnecessary part reduced by that much, the trouble and repairs for the man using the engine. Our engine has only *three moving parts.*

The Mudge Equipment sells for a very reasonable price for cash or, if you desire, it will be shipped to you for use while you are paying for it in installments, by our easy monthly payment plan.



Mudge Engine equipment applied to hand car
Runs either forward or backward

Burton W. Mudge & Company
1059 Peoples Gas Building, Chicago
Without obligation to me send information about "The Mudge Engine Equipment."

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Occupation.....

R. R......

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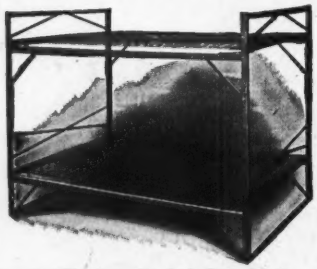
SALES SERVICE COMPANY—ADVERTISING—CHICAGO

Give Your Men Needed Rest When Sleeping



No. 185 "Tiger" Double Deck Bunk Set Up.

And be Repaid Threefold Through

Increase in Work Done—
Better Class of Men Secured—
Lower Ultimate Cost of Equipment

The "Tiger" Steel Bunk is a Permanent Investment. Built to stand all kinds of Hard Knocks—It's Bug Proof.

Showing Head Room, Height, Etc.

"Tiger" Steel Bunks

This Bunk is on Exhibit at

Space No. 289
First Regiment Armory

During the Maintenance of Way Convention

The spring fabric, though elastic, can never sag—made with wire link fabric, secured to frame by oil tempered helical springs—CANNOT BREAK DOWN.

Made in either Double or Single Deck—All Sizes.

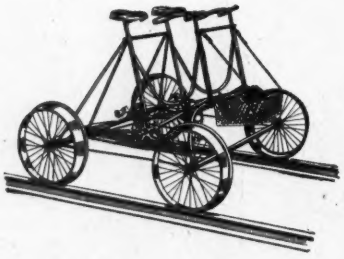
Write us for Illustrated Circular Showing Styles and Prices.

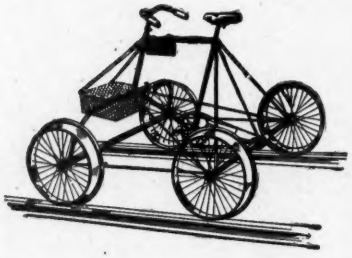
Six men weighing about a half ton did not injure this Bunk after giving it the above unusual, unfair test.

Haggard & Marcusson Co.

1120 West 37th St., Chicago, Ill.

HARTLEY & TEETER

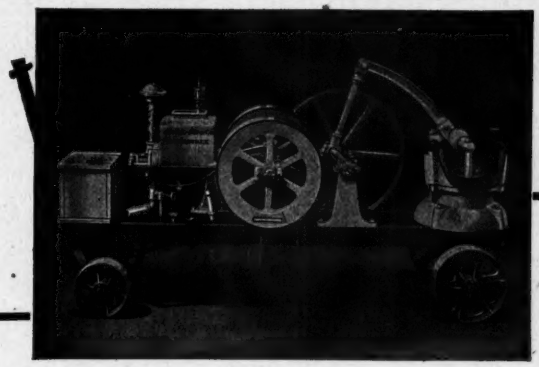




Light Inspection Cars are the Strongest and Lightest running known. The fact that we constantly receive repeat orders is proof absolutely that our cars are giving entire satisfaction. We shall be pleased to supply you with our new catalog that tells all about them.

LIGHT INSPECTION CAR CO.

HAGERSTOWN, INDIANA



PUMPS 40 GALLONS WHILE PAT STOPS TO LIGHT HIS PIPE

Put this portable power driven diaphragm bilge trench pump on your job.

The C. M. & St. P. Ry. Co. have just placed eighteen of these Pumps on their different jobs. Ship us your old hand pumps. We will mount them for you in connection with our Power Driven outfit.

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For our attractive catalog—just off the press.

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CALUMET SUPPLY MFG. CO.
MANUFACTURERS OF
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STEEL CATTLE GUARDS
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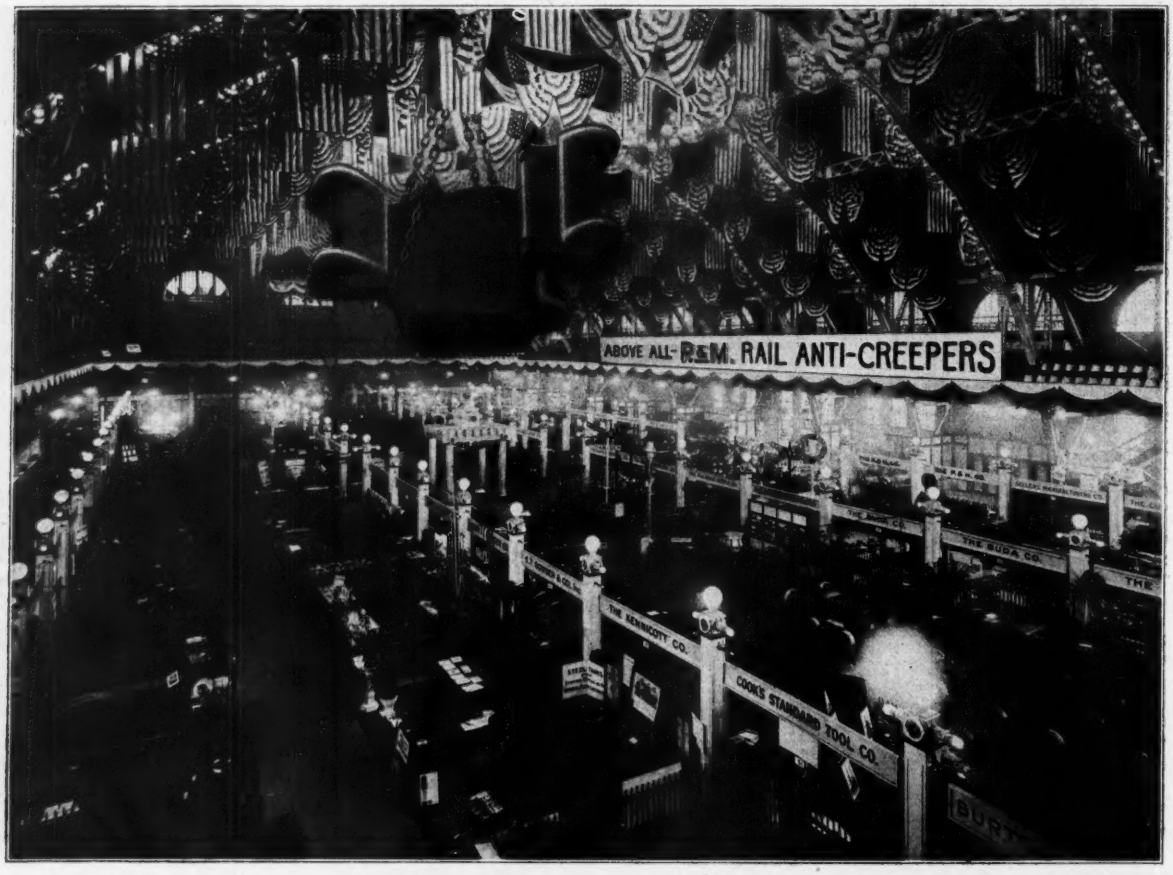
WE SPECIALIZE IN MAINTENANCE OF WAY EQUIPMENT
OFFICE 1213 KARPEN BLDG. CHICAGO WORKS HARVEY, ILL
WRITE FOR PRICES AND 1913 CATALOGUE

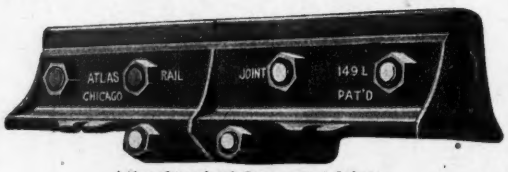


ATLAS RAIL JOINTS, TIE PLATES AND BRACES

ATLAS SWITCH STANDS AND CAR MOVERS

Atlas Tie Plate

Atlas Primer and Surfacer for Your Cars



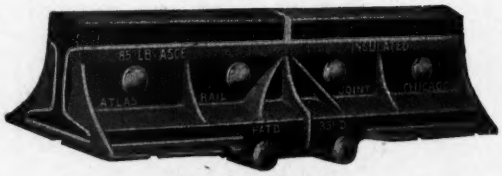
Atlas Standard Suspended Joint

Atlas Compromise and Insulated Joints

Made either of Atlas Special Malleable Iron or of High Grade CAST STEEL

Atlas Compromise or Step Joint
Made to Fit any Combination of Rails, Tee or Girder

Made Either Suspended or Supported



Atlas Insulated Joint

ATLAS RAILWAY SUPPLY COMPANY, 1523-7 Manhattan Building Phone Harrison 2900 Automatic 69205 CHICAGO

Write for Circular "M"

Cuts the heaviest rail in 40 minutes

30 Days' Trial

If the

Schmidt Hack Saw Machine

doesn't fill the bill, send it back. No cost to you to try it.

Particulars on Request

Track Necessities Company
38 Van Buren Street CHICAGO

Wyoming Shovels

Are Built at Our Plant and Not Just Assembled

Every part of a Wyoming Shovel is made right here at Wyoming—handles of the finest second growth Northern Ash, and blades the highest grade crucible and open hearth steel. Our trade mark on a shovel is a guarantee for wear and service.

THE WYOMING SHOVEL WORKS • WYOMING, PA., U.S.A. • REG. U.S. PATENT OFF.

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Established 1873

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TRADE MARK.

Insulated Wires and Cables

will continue giving satisfactory service long after their purchase has been forgotten—made in but *one* grade—the *best*.

Look for the Ridge

A distinguishing mark on *genuine* OKONITE insulation consists of a single ridge running the entire length of the wire.

The Okonite Company
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Central Electric Company,
General Western Agents
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ANTOX is the name given to a series of protective paints.

These paints are absolutely Water, Brine and Corrosion proof.

ANTOX Coatings withstand solutions as virulent as 35% Sulphuric Acid or Caustic of Potash.

ANTOX paints are specialized to meet the exacting demands of modern steel rolling stock and specific industrial needs.

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Sole Manufacturers, Indianapolis, Ind., U. S. A.
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All Because He Didn't Use A "Coes" Wrench

This tells the story of how the accident happened which laid him up for six weeks.

He was reaching way down trying to loosen a rusty nut. Everything depended upon the ability of the wrench to hold—but it didn't. It failed at the critical moment, slipped, and—

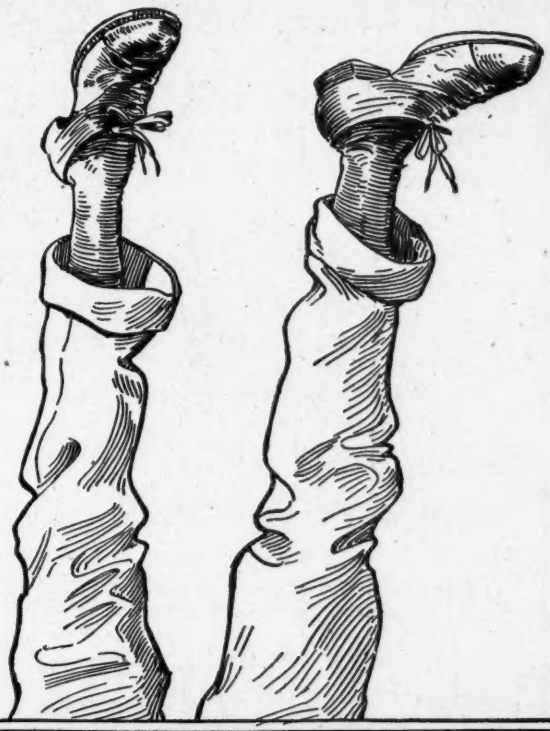
Well, after Jim got out of the hospital he decided to use "Coes" Wrenches on all future jobs.

That's the advantage of sticking to a "Coes" Wrench. It will stick to the nut and you can always depend upon it. Many an accident has been avoided because "Coes" Wrenches were used.

Take no risks. Use "Coes" Wrenches because you can trust them absolutely.

Coes Wrench Company,

Selling Agents: J. C. McCarty & Company, 29 Murray Street, New York

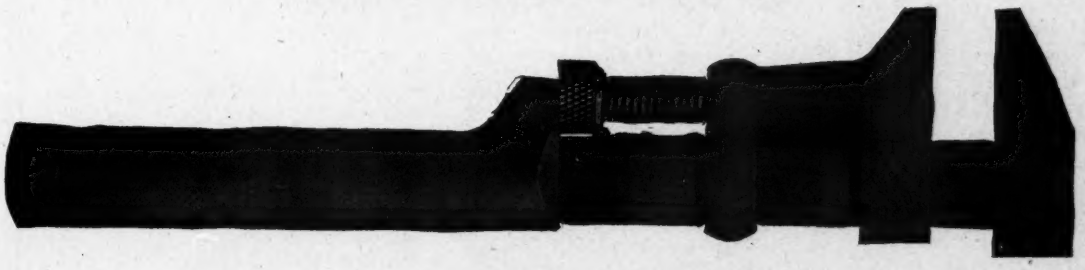


There's Highest Quality in "Coes" Wrenches

It's the high quality in "Coes" Wrenches, the way they are made and tested, the correctness of the mechanical design, and the superior workmanship shown in every part that make genuine "Coes" Wrenches so reliable under all conditions.

Isn't it worth the slight difference of 5% higher cost to get the assurance of safety, highest quality and 30% greater strength?

Ask us for the "Coes" Wrench Book.



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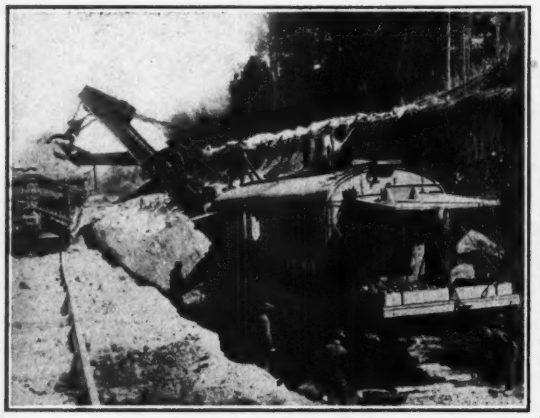
Selling Agents: John H. Graham & Co., 113 Chambers Street, New York

Bucyrus Steam Shovels



Where More Than One Shovel Is at Work on a Job, the Bucyrus Will Always Be Found in the Hardest Digging.

Ask the Man Who Pulls the Levers

We Also Build
Shovels of all sizes, dragline excavators, dredges, wrecking cranes locomotive pile drivers, and unloading plows

BUCYRUS COMPANY
South Milwaukee, Wis.
NEW YORK CHICAGO BIRMINGHAM DULUTH
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Pump Water at Less Cost

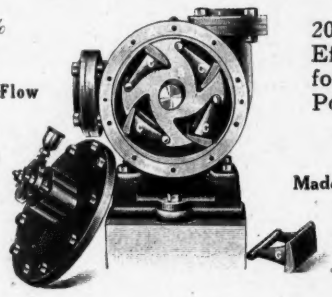
The Blackmer Rotary Pump

Especially Adapted to Water Tank Installation

75 to 80% Efficiency

Continuous Flow

Made in sizes with capacities of from 5 to 500 gals. per minute.



20% added Efficiency for Given Power

Made in either Bronze or Iron as Conditions Warrant

Principal Wear Comes on Detached Buckets

Which can be replaced without disturbing connections

Repair Parts Obtainable at Their Proportionate Cost to the Assembled Whole

Made in single or double direct connected units

Let Us Figure on Your Next Installation

Blackmer Rotary Pump Power & Mfg. Co.
Petoskey, Mich.

AN OPEN LETTER

Mr. Railroad Man:

We cordially invite you to visit the Permanent Manufacturers' Exhibit of Railway Supplies and Equipment and assure you of our earnest endeavor to make your stay, whether brief or protracted, both pleasant and profitable.

We offer you, among other things, not only an opportunity to view quietly and unmolested, numerous railway devices, but we also extend to you the privileges of our Club during your stay in the City.

You can check your baggage here, write your letters, telephone your friends, and make this your headquarters during your visit, and also have your mail sent in our care.

A Public Stenographer is in attendance on the main exhibit floor, and a good Restaurant and Grill is maintained in connection with the Club.

Come and see us.

Yours fraternally,

ALLEN SHELDON,
Manager.

Meetings During Convention Week

Division Engineers, Pennsylvania Lines West, Mornings, March 18th and 19th.
Western Railway Club, Tuesday night, March 18th.

RAILWAY SUPPLY EXHIBIT

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The One Product That the Term

WATERPROOFING

can be applied to without fear of successful contradiction

"IRONITE"

For Waterproofing and Preserving Battery Wells—Concrete Posts and Water Tanks—Wooden Trunking and Insulating Blocks for Rails — Foundations for Carriers, Poles and Copings, and also Bonding Junction Boxes and Conduits.

Forms Perfect Bond Between Old And New Material

Easily Applied—Comes in Powder Form—Just Mix with Water and Apply with Brush

Ironite Flooring Makes Concrete Impervious to Moisture or Wear

A FIVE YEAR GUARANTEE AGAINST SATURATION

INEXPENSIVE

BERTRAM BLOUNT, F. I. C. London, Eng., says:

"I am of the opinion that Ironite is a material of great value for rendering structures waterproof and making porous surfaces impermeable."

JOHN F. LINDGREN, Chief Cement Tester, Illinois Central R. R., Chicago, says:

"From my experiments with Ironite extending over a period of 6 years, in my opinion Ironite is unqualifiedly the best waterproofing and bonding material known today. For concrete work, Ironite Flooring adds greatly to the life of the concrete, on account of its non-absorbent strengthening and wearing qualities."

The United States Government, Bureau of Standards, reporting on a test of Ironite and other waterproofing material says:

"This was the only compound out of twenty-six tested to pass all the tests successfully."

LET US PROVE ITS WORTH TO YOU

CUT OUT AND RETURN THIS COUPON

M. J. EGLESTON, Ry. Sales Agt., Karpen Bldg., Chicago, Ill.
Without obligation on our part, please send prepaid and without charge, one pound package of Ironite Waterproofing, with instructions for application.

Name.....

Railroad.....

City..... State.....

M. J. EGLESTON, Railway Sales Agt.,

KARPEN BUILDING, CHICAGO, ILLS.

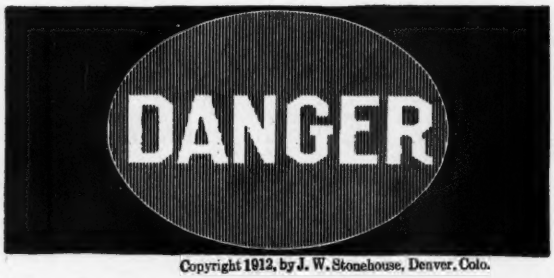
Has demonstrated by Service Test that a train of eight loaded cars on level track at speed of eight miles an hour was fully stopped when third corrugation was reached.

WE BELIEVE IT SO THOROUGHLY THAT WE OFFER TO INSTALL THEM SUBJECT TO YOUR APPROVAL AFTER TEST TRIAL

AUTOMATICALLY PERFORMS THE FUNCTIONS OF AN EMERGENCY BRAKE WITHOUT DAMAGE TO TRACK, STOPPER OR CAR EQUIPMENT NO MATTER WHAT THE SPEED.

SOUTHERN RAILWAY SUPPLY CO., MFR'S AND SALES AGT'S | 113 N. SECOND ST. ST LOUIS, MO.

THERE IS NO



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Of Mistaking the Meaning of This Sign

The word DANGER appears in white on a brilliant red oval set on a black background.

The color combination is striking—it immediately conveys a warning, and its brilliancy and sharp contrasts compel attention.

It is cheaper to install this sign than to install a wooden one; in fact it's cheaper to install a new **Universal** sign than to pay for maintaining an old wooden one. **Universal** signs will not chip, crack, rot or fade, and they are so well protected by the enamel that they will practically never rust. The colors and letters are **burned on,** and they will **stay on.** Weather and smoke does not dim the brilliancy of these signs.

Our manufacturing facilities enable us to make these signs in quantities and allow us to quote surprisingly low prices. These three considerations—the brilliancy and sharp contrasts which compel attention—the durability —and the low price—have set in motion a campaign to make the Universal the **Standard** danger sign. We will be glad to send you, without charge, a full sized print of the Universal in colors, and furnish prices.

We can also quote some very attractive figures on special enameled signs and notices for platforms, crossings, culverts, bridges, waterways, cattle passes, third rails, slow speed sections, whistle posts, yard limits and siding.

Let us figure on your requirements.

The Stonehouse Enameled Steel Sign Company

907 EIGHTEENTH STREET :: :: **DENVER, COLO.**

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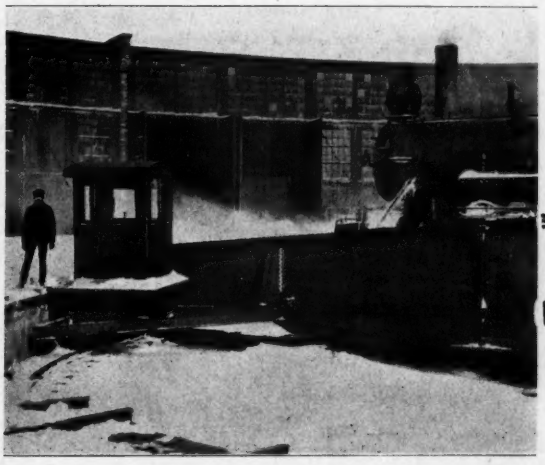

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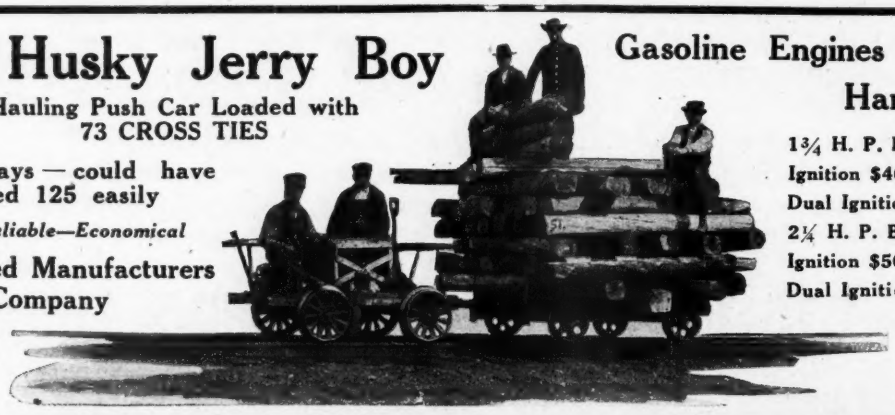

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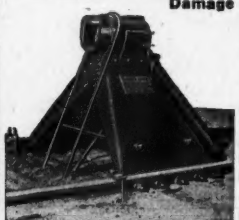

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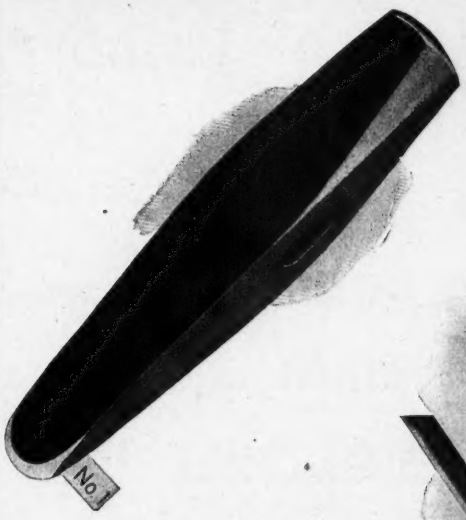

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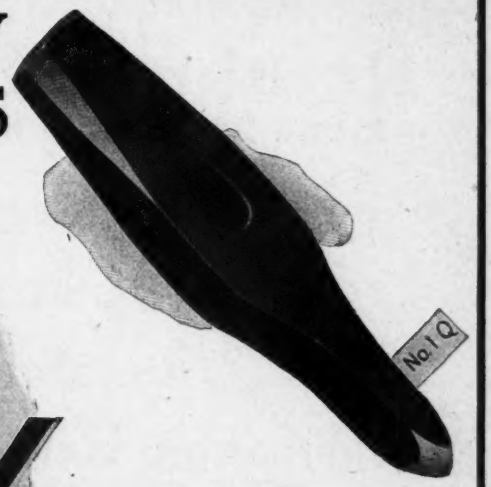

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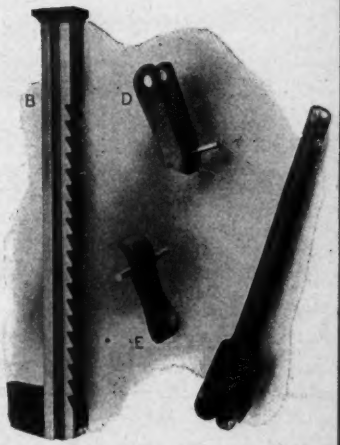

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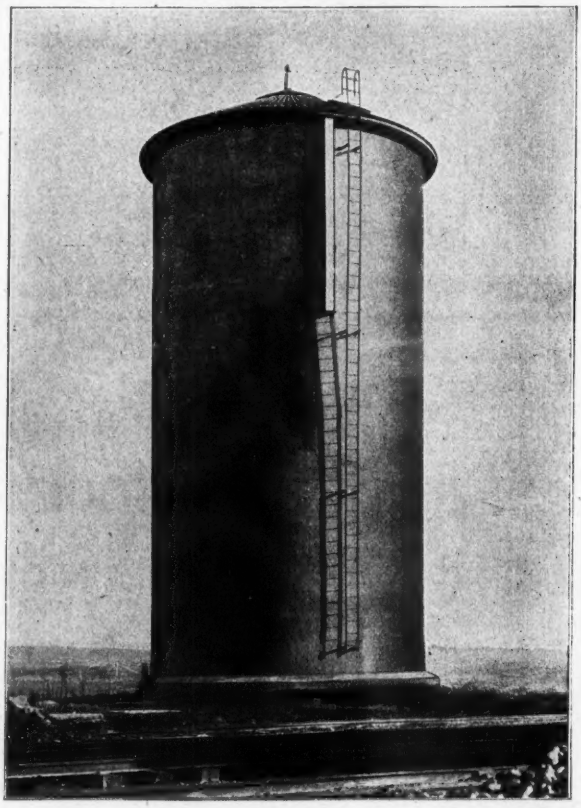

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This Publication has the largest paid circulation of any railway journal in the Maintenance of Way field.

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Chicago, April, 1913 No. 4

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Grade Crossing Elimination by Legislation

ALL GRADE crossings in the state of New Jersey are to be eliminated entirely at the cost of the railways if the bill which has passed both houses of the state legislature is not declared unconstitutional. With reference to the bill, President Rea of the Pennsylvania writes as follows:

> It is important that the public should understand that in the passage of this bill a grave injustice has been done the railroads. The Pennsylvania Railroad Company has long been committed to the policy of eliminating grade crossings as speedily as possible, and is anxious that no laws be passed which will tend to deter, rather than encourage, the rapid removal of all grade crossings. In the last 20 years the Pennsylvania has removed 110 crossings in the State of New Jersey alone, at an expense to the company of about $8,000,000, or $73,000 per crossing. It has elevated its tracks through the large cities along its lines in New Jersey. Much more would have been accomplished if the various lines in the system had been able to carry the financial burden. But, as it is, there are very few crossings of its railroad at grade in any of the cities. The company is now engaged in the work of track elevation through the city of Rahway, and eastward. There remain, however, some twelve hundred grade crossings on the Pennsylvania in New Jersey, the removal of which at $50,000 per crossing would cost $60,000,000, an expenditure which would neither produce additional revenue, nor decrease expenses. The removal of grade crossings should unquestionably continue. The need is for some impartial tribunal which shall have authority to arbitrate between the Municipality and the Railroad company and to bring them into co-operation if they cannot agree. Power should be vested in some administrative board, acting judicially, to take up, on the application either of a municipality or a railroad company, or on its own initiative, the case of any grade crossing, and after a hearing to direct the elimination of the crossing and the particular manner in which it shall be done and how the expense shall be proportioned. Generally speaking, such is the arrangement in New York, Massachusetts, Vermont and Ohio. Such a plan protects the public and provides for ascertaining the proper burden which should surround the settlement of each particular problem. With so many crossings still to be eliminated, it seems unfair and unwise to propose that the railroad companies should be burdened with either the entire cost, or an undue proportion of the cost, of eliminating grade crossings, many of which have been opened subsequently to the construction of the railroads, and against their strong protests. It should also be borne in mind that the flat contour of the State of New Jersey has made many crossings at grade a very natural development.

It would seem that any fair-minded person must agree with Mr. Rea in his objection to a law so sweeping in effect. The diverting of millions of dollars from channels of more legitimate expenditure to the elevation of the crossings of little used country cow-paths would certainly not gain popular approval of the action of the legislature if the money were to come from public funds, and it is equally unwise to attempt to force this burden upon the railways. It is a well known fact that the statements of Mr. Rea as to the voluntary elimination of grade crossings, where traffic warrants the change, are

true. Legislation of the type referred to, is an indication of lack of appreciation of this fact.

From an engineering standpoint the plans for grade revision so comprehensive as would be necessary in complying with this legislation, would be very interesting.

More About Editorial Policy.

A GOOD many messages come to this office suggesting that more attention be paid to certain features in the railway engineering or maintenance field. Such suggestions are always welcome, and many of them are valuable and are acted upon.

There are a number of different subjects which must be taken care of, and it is possible that all do not realize the importance of certain kinds of information to the "other fellow."

Recently a man said, "The most valuable articles to me are those showing photographs, giving details of architecture, finish, and appearance." From the standpoint of one class of designers, such articles could occupy the largest space with profit.

Construction engineers form a very important part of our railway organizations, and as a class they are greatly interested in articles describing and illustrating different methods used in construction, the order of and different steps necessary in successful construction. The finish of structures also is of vital interest to them, while design and architectural appearance do not awaken the same interest.

Most designing engineers are interested in architectural appearance, and in finish, therefore in illustrated articles. The problems of construction should interest them, for the designs should be made with certain construction requirements and limitations in mind. As a rule, however, the articles of absorbing interest to this class are those giving formulæ, data and analytical deductions, which are of immediate benefit in engineering design.

In the maintenance of way department, it is in general the expressions or suggestions of practical men which are considered of the greatest importance. But in this department, the wide-awake man keeps informed, as far as may be, also on construction matters, for much construction work is carried on by these forces. The suggestions of the practical man, if conveyed forcibly to the man in charge of design, will often result in a lower cost of maintenance or higher working efficiency in the structure designed.

The general and rapid growth of signalling, talk of and experiments with "combined organization" makes it advisable for the maintenance man to know as much as possible of the general features of this work, and the engineers should also be interested in this development, as they are usually in charge of a portion, at least, of the construction work involved.

The office of this publication is to depict, mayhap in an imperfect way, the development in railway construction, revision, and maintenance, with all the problems connected therewith. Much which is not of direct interest should prove of just as great value as a preparation for future work and enlarged responsibilities.

Very few articles are published of a deeply technical nature, as it is the aim in every article, only to furnish such information as is directly applicable by at least one class of readers. Such articles, containing simple formulæ and deductions, in the aggregate, form foundations for books, in which the theory is frequently gone into exhaustively—but such profound theory is clearly outside of the scope of a technical periodical.

The scope of a technical publication is to keep its readers apprised of the constant, day by day developments in the field which it represents, before such information is available in books. And in doing this the whole field must be considered, the general tendency of the times partially controlling the proportions of different subjects dwelt on. And one page of information on a live subject is worth more than a volume of profound theory on a dead subject.

If every man can bring himself to realize a fraction of the importance of the "other fellow's" business, he will find much that interests him in many articles foreign to his own specialty.

Our Critics.

THE EDITOR of a journal devoted to the interests of the musical instrument manufacturers was recently convicted of conspiracy to extort money from a piano manufacturer by threats to publish articles derogatory to the business of the latter. The editor in question, with his co-conspirators, seems not to have gone to the manufacturer with even the semblance of a straight business proposition. It was, pay tribute or suffer consequences. Of course these tactics eventually cost the over-ambitious editor his right to liberty.

In the field of many class publications the associations are so close and the competition so keen that mention in anything but a complimentary way, of some manufacturer's product or his methods in the publication widely read by his prospective purchasers, brings down upon the responsible editor the contents of large vials of concentrated wrath. "Blackmail," is the injured manufacturer's charge and the problem of the right thinking editor is to tell all of the truth, which will benefit his readers without hurting any innocent person.

The problem is made the more difficult because of the fact that the publisher's organization is supported by the income from the advertisments carried in the publication by those who have reason to believe in the efficacy of such publicity. The readers of the advertisements are, however, the readers of the editorial and subject matter, and the former would attract little real serious interest if the latter is not of such quality as to command respect.

The mediocre editor of the mediocre journal goes on year after year editing and writing wish-wash matter, avoiding the truth if it hurts, and praising the merest stock-jobbing fake, for the sake of "policy." He earns his mediocre income from the advertisements of those manufacturers who do not take time to trace returns and who patronize the journal on the strength of welcome silence as to certain tactics, or compliments paid them and their business. The publication which really merits this advertising is the one, the readers of which have found that its contents are not colored to suit as many advertisers as possible.

Unquestionably the easiest editorial policy is the one which avoids the mention of the unsavory truth, no matter what the benefit thus lost to the reader. The editors of *Railway Engineering* must admit the practice of different methods. We believe our first duty is to the reader and that the right-thinking manufacturer must agree even if his own toes are stepped upon.

Floods.

A STARTLING situation has developed in the middle west which made impossible the operation of any of the lines of the railways of Ohio and Indiana for some five days in some cases and much longer in others. These two states were practically under water during this time. Six inches of rain fell in this district within forty-eight hours, resulting in floods greater than ever before experienced.

On the Pennsylvania Lines west of Pittsburgh, an aggregate of a mile and a half of steel bridge works was washed away—a total loss. It is stated that the New York Central Lines and the Baltimore & Ohio Systems will each be put to an expense of about $3,000,000 for repairs alone.

The surplus earnings of several of the roads concerned will be entirely wiped out by this unforeseen expense which must come out of current earnings and cannot be charged to capital.

Truth in Advertising, No. 2.

Editor Railway Engineering:

After reading an article in the February issue of your paper on the subject of truth in advertising in which I was much interested, the thought occurred to me that there are other phases of the situation just as important as the accurate description of the articles advertised in technical publications. You mention the man of patent medicine experience who occasionally succeeds in getting into the engineering field. The results of that man's work, however, are often evidenced before he gets to the copy writing stage. His selection of the publications which carry his advertising in the exploitation of patent medicines has been made, not on the basis of reaching a certain restricted class of people or upon peculiar merits of the publication used; on the contrary, one reader is as good as another in his eyes and his advertisements appeared in publications which would accept them at his terms.

In the engineering field, an advertisement out of place carries with it an element of doubt. At the start the publications are read by one class of people exclusively; therefore, when a reader finds an advertisement out of place in his publication or when his favorite publication fails to carry the "ad" of a large concern doing business among the members of his class, and he has knowledge that the concern is advertising extensively the product used by his class, almost exclusively in journals not read by him and his contemporaries, he is apt to place upon the product the stamp of his disapproval.

When a certain product is manufactured by a number of concerns in different parts of the country, and an organization for the purpose of an economical system of sales is made, the cost of advertising of the combined interests is often divided among all and paid for out of an appropriation made in annual convention. A committee appointed by the association is given the task of selecting the journals to be used as mediums. The members of this committee are apt to be in more or less irresponsible moods during a convention when they are outside of their regular office environment. They are susceptible to entertainment and, no matter how honest their intentions, the disposition of the appropriation if made during convention is almost sure to be inconsistent and to reflect the irresponsible atmosphere of the temporary environment. The resulting effect is not to the best interests of the association and the money spent is often worse than wasted. E. M. B.

New Orleans, La., March 14, 1913.

The Galveston, Harrisburg & San Antonio is planning to extend its Sylvan Beach spur at Houston in the direction of Morgans Point.

Correction.

IN the article on "Design of Retaining Walls" in the March issue the equations near the bottom of page 148 should read as follows:

$$12 \times 3\ (\tfrac{1}{2}\ b - e) \times \frac{f}{2} = V, \text{ whence}$$

$$f = \frac{V}{18\left(\frac{b}{2} - e\right)}, \text{ for one foot of wall.}$$

This error was plainly discernible; the equation is obtained from a triangle, and the area should have read ½ the width times the altitude, whereas the equation stated the area was the entire width times the altitude.

RAILWAY CONSTRUCTION.

The Bainbridge & Northeastern has applied to the Georgia railroad commission for authority to issue $1,500,000 of bonds to construct a 50-mile line connecting Pelham, Bainbridge and Hardaway, Fla.

The Baltimore & Ohio is understood to have under consideration the expenditure of about $800,000 for establishing yards at Miller, Ind.

The Bloomington Southern has awarded a contract to Scott & Son Construction Co., St. Louis, Mo., for building a 2-mile spur into the Ohio Stone Co. holdings near Victor.

A bill has been introduced in the Ontario legislature providing for the increase of the capital stock of the Bruce Mines & Algoma from $300,000 to $12,000,000, and to change the name to the Lake Huron & Northern Ontario Ry. The new charter, it is said, contemplates the construction of 500 miles of railroad in the Algoma district.

The Cambridge & Chesapeake will construct a line 25 miles long from Cambridge to Fox Creek, Md., by way of Church Creek, Madison and Taylors Island.

The Canadian Pacific has let contracts for 165 miles of double tracking on its Lake Superior division and Ontario division, as follows: Jones & Girouard, Ottawa, Ont., from Guelph Junction east to Islington, 30 miles; Cook Construction Co., Sudburg, Ont., 30 miles; Cartier subdivision of Lake Superior Division; Dominion Construction Co., Toronto, Ont., 84 miles; McQuaig, McCaffrey & Cochrane, 22 miles.

The Caroline & Yadkin River has contracted for the construction of an extension from Thomasville, N. C., to High Point, N. C., a distance of about 8 miles. The contract has been awarded to C. W. Lane & Co., Augusta, Ga.

The Central of Georgia, it is reported, is preparing to make numerous improvements on the Eufaula and Ozark branch, a distance of 60 miles. The work will include improvement of roadbed, bridges, etc.

The Chicago, St. Paul, Minneapolis & Omaha is reported to be planning to take over the right of way of the proposed Scandinavian Ry., which has been surveyed from Lake Stretch to Ruthton. It is said that the Omaha will extend its branch from Currie northwest a distance of 30 to 40 miles.

The Chicago, Rock Island & Pacific has appropriated $200,000 for improvements at Fairbury, Neb., one-half of which will be spent this year. The improvements will include the enlargement of the yard, work on which will be started at once. A change of main line is also included.

The Columbia & Nehalem River has made application for a charter to build an electric or steam railway from Wood's Landing in the eastern part of Clatsop county, Ore., to the Nehalem valley. The capital stock is $1,000,000.

The Chicago & North Western in the early spring will probably take up the extension of its line west from Winner, S. D.

The Duluth & Northern Minnesota, it is reported, will start this spring on an extension of its line from the present terminus to Fort William, Ont., a distance of about 60 miles.

American Railway Engineering Association

Report of 14th Annual Convention.

The fourteenth annual convention of the American Railway Engineering Association was called to order at 9:30 a. m. Tuesday, March 18, by President C. S. Churchill, chief engineer, Norfolk & Western Railway.

PRESIDENT'S ADDRESS

During the last year there has been an increase of 62 in the membership, making a total of 1,066. The aggregate of printed matter during the year was 30,366 pages.

The methods advanced at the last Convention for increasing revenue and decreasing expenses, has resulted in increasing the cash on hand $3,183.11 in excess of what it was in 1912.

The American Railway Association has made the following appropriations for the rail committee: $5,000 in 1910, $6,000 in 1911, $10,000 and $10,000 in 1912, making the total $31,000.

The Association, by invitation, appointed a committee to attend the Fourth National Conservation Congress at Indianapolis in September. Messrs. McNab, Atwood, Ferriday, Fink and Young, attended as delegates.

The first notable accomplishment of this Association was the standardization of materials, designs and specifications.

So far, more attention has been given to materials than to labor. The labor question is an important one and scientific care, supervision, etc., should be developed.

The Rail Committee has shown that extreme watchfulness is necessary in manufacture. To date this committee has shown (1) That at first there were as many explanations of rail failures as there were manufacturers, but now we have the general causes, and remedies are being worked out. (2) Bad practice will vitiate the advantages or disadvantages of any particular rail section. (3) The amount of discard from the top of the ingot seems to show the relative skill of some mills in controlling the manufacture, rather than indicating the quality of the rail produced. (4) Some mills produce continually better and more uniform rails, due to skill at the mills, which has been considerably developed by the publications of this Association. (5) The use of the thick base rails—A. R. A. section—is reducing rail failures to an insignificant number, and that careful labor should follow the rails until they are removed from the track and scrapped.

This Association should keep up-to-date in labor-saving machinery, best organization and supervision. A practice should be made of commending good practice, as well as condemning bad practice. Encouragement, in addition to wages, is necessary to bring out the best in men.

The prize system has worked out to good advantage in maintenance work. The collection and interchange of cost data also provides an incentive towards more efficient work. There is undoubtedly a large mass of data as to labor and appliances for cheapening handling of materials, which should be compiled for our Proceedings. The latter subject is a progressive one, and one which a committee could probably never complete, due to the great strides and improvements inaugurated every year.

Studies of such methods have resulted in the completion of the Norfolk & Western Railway crossing over the Ohio River, by the cantilever method of construction. The spans were built around the old ones on the old masonry. The central span is 520 ft. long. The consideration which led to this type of construction was economy in time and labor, and minimum delay to railway traffic, and none to river traffic.

Another study has led to the undertaking of electrification of 27 miles of that portion of our line having steepest grades and densest traffic, freight traffic mainly.

A saving in cost of labor applying materials is net income to the railways. I have often noticed gangs of similar size, in different parts of the country, which do not produce anywhere like a similar condition on the railways. This illustrates the fact that they are not all working to a definite plan, and it is just as easy to work to a definite system. The railways with densest traffic seem to accomplish a high grade maintenance at lowest cost.

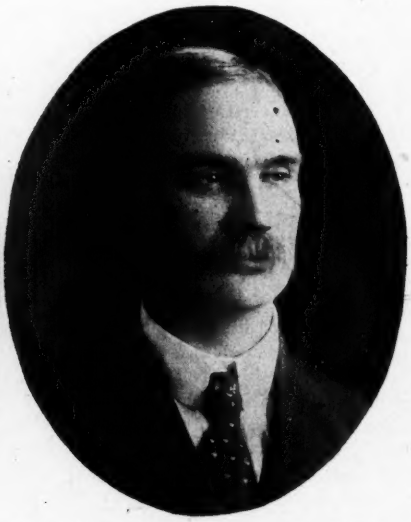
The American Railway Engineering Association can aid in the improvement of labor efficiency, just as it has and must continue to improve the standards of materials and specifications.

SECRETARY'S AND TREASURER'S REPORTS.

Balance on hand December 31, 1911		$ 7,562.15
Consisting of:		
Six railway bonds	$ 5,206.06	
Cash in bank	2,356.09	
Total		$ 7,562.15

C. S. Churchill, President, 1912-13.

E. H. Fritch, Secretary (Re-Elected).



George H. Bremner, Treasurer (Re-Elected).

Receipts during the year 1912:		
From members	$13,363.25	
From others—sales of publications, advertising, etc.	6,111.19	
From Am. Ry. Assn., Rail Com. fund	7,961.81.	
From interest on bank balance	123.66	
From interest on investments	280.00	
Total receipts in 1912		$27,839.91

Summary.

Receipts during 1912		$27,839.91
Expenditures:		
Dec. 1911 vouchers, paid Jan. 4, 1912	1,047.68	
Vouchers for 1912	$23,609.12	24,656.80
Excess of receipts over expenditures	$ 3,183.11	3,183.11
Assets December 31, 1912		$10,745.26
Consisting of:		
Six railway bonds	$ 5,206.06	
Cash in bank	$5,539.20	
Total		$10,745.26

RULES AND ORGANIZATION.

Jos. O. Osgood, Chairman; G. D. Brooke, Vice-Chairman; F. D. Anthony, J. B. Carothers, S. E. Coombs, J. B. Dickson, C. Dougherty,

W. T. Eaton, J. A. Gordon, K. H. Hanger, B. Herman, Jos. Mullen, E. T. Reisler, A F. Stewart.

The subjects assigned the Committee for this year were to continue the work of last year, as follows:

(1) The compilation of rules for the government of maintenance of way employes, and

(2) The formulation of rules in the nature of specifications or instructions regarding the conduct of work, making use of the recommendations of the various Committees dealing with these subjects and of the best practice of Railway Companies as embodied in their books of rules.

In accordance with the first instruction, the Committee recommends that revisions and additions be made in the General Rules for the Government of Employes of the Maintenance of Way Department heretofore adopted by the Association, as follows:

Revise Rule No. 8 under "Track Supervisors," "Track Foremen," "Supervisors of Structures," "Bridge and Building Foremen," "Signal Supervisors" and "Signal Foremen" to read as follows:

Present Rule.

(8) They shall conform to the prescribed standards and plans in the execution of work under their charge.

Proposed Rule.

(8) They shall conform to the prescribed standards, plans and specifications in the execution of the work under their charge.

Insert under "Track Foremen" a rule to be No. 17 and reading as follows:

They must keep all interlocking pipe lines and trunking free from grass and weeds and all switches, frogs and movable parts of interlocking plants free from snow, ice and other obstructions.

Under "Track Foremen" change Rule No. 17 to be No. 18.

Jos. O. Osgood, Chairman Committee on Rules and Organization.

Insert a rule under "Track Supervisors" to be No. 17 and under "Track Foremen" to be No. 19 to read as follows:

Any action proposed by County, Township, Municipal or other authority, which will in any way affect the Company, shall be reported immediately to the (Title)

.....

Insert under General Notice rules to be No. 12 and No. 13 and reading as follows:

(12) The use of intoxicants by employes while on duty is prohibited. Their use, or the frequenting of places where they are sold, is sufficient cause for dismissal.

(13) Employes subject to emergency call shall notify their immediate superior officer and the Division Superintendent of any change in address, whether temporary or permanent.

In accordance with the second instruction, the Committee recommends that the following rules be added to the "Instructions" which were presented and adopted by the Association at its convention of last year:

Tie-Plates.

27. Tie-plates must be used wherever ties wear out faster than they fail by ordinary decay. They must be put on so as to get a full and level bearing on the tie and against the rail.

Gaging:

28. Perfect gage is one of the essential features of good track; gage kinks are as detrimental as low joints.

29. The standard gage is 4′ 8½″. Curves eight degrees (8°) and under should be standard gage. Gage should be widened one-eighth inch (⅛″) for each two degrees (2°), or fraction thereof, over eight degrees (8°) to a maximum of four feet nine and one-quarter inches (4′ 9¼″) for tracks of standard gage. Gage, including widening due to wear, should never exceed four feet nine and one-half inches (4′ 9½″).

30. The installation of frogs upon the inside of curves is to be avoided wherever practicable; where this is unavoidable the gage of the track at the frog should be standard.

Curve Easement.

31. On all curves the amount of super-elevation to be given to the outer rail and the proper easement to be provided at the ends shall conform to the standards for "Track" prescribed by the American Railway Engineering Association and published in the Manual, edition of 1911.

Switches.

32. Switches must be placed in accordance with the standard plans and as located by the Engineer.

EDWIN FREDERICK WENDT, assistant engineer, Pittsbugh & Lake Erie R. R., was elected president of the American Railway Engineering Association, 1913-14. He was educated in the public schools of New Brighton, Beaver County, Pa., and graduated from Geneva college, Beaver Falls, Pa., in 1888 with highest honors in the classical course, receiving the degree of A. B. He entered railway service in September, 1888, as axeman and chainman on an engineering corps of The Pittsburgh & Lake Erie R. R. and served continuously with that road in the different positions of axeman, chainman, rodman, levelman and transitman to October 1st, 1898, since which date he has been, to the present time, assistant engineer (under the Chief Engineer) in charge of maintenance of way, construction and contract work.

Edwin F. Wendt, President, 1913-14.

He was elected a member of the Engineers' Society of Western Pennsylvania in 1890; a member of the American Society of Civil Engineers in 1903; and a charter member of American Railway Engineering Association in 1900. He was chairman of the committee on "Records and Accounts" of the American Railway Engineering Association during 1903, 1904 and 1905; member of committee on "Signals and Interlocking," 1906 to 1913, inclusive; a member of the Board of Direction during 1908, 1909 and 1910; chairman of committee on "Publications" during 1912-1913; second vice president in 1911, first vice president in 1912, and president of American Railway Engineering Association March 20, 1913.

33. Switches and frogs must be kept well lined and in good order. Particular care must be taken to maintain good surface at switches.

34. Switches must be inspected frequently to see that they are in working order and that all nuts, bolts and other fastenings are in place and properly tightened. Broken or damaged parts must be renewed promptly.

35. Switch points must fit closely and accurately to the stock rail, which must be bent to suit the angle of the switch. The bend in the stock rail shall be at such distance ahead of the switch point as will make the gage line continuous.

36. Lead rails in all turnouts must be curved with a rail bender before being laid.

37. All main track switches leading to sidings or branch lines should be protected by switch connected derails.

Switch Ties.

38. Switch ties must be used for all permanent turnouts, crossovers and railroad crossings and placed as shown on the standard plans.

Guard Rails.

39. Frogs must be protected by guard rails, constructed and placed in accordance with standard plans. The tops of the guard rails must be level with the tops of the main rails and must be securely held in place.

40. Guard rails must be so placed that the distance from the gage side of the head of the frog wing rail to the flangeway side of the guard rail shall be exactly four feet six and three quarters inches (4′ 6¾″) and great care must be taken to preserve this distance.

Track Posts and Signs.

41. All signal posts, whistle posts, mile posts, signal targets, bridge and other standard signs must be kept plumb and in good condition.

42. Whistle posts must be placed so as not to be obscured by fences or other signs.

Care of Track Tools.

43. Tools must not be left standing within six feet (6′) of the nearest rail of the track on which a train is approaching.

Road Crossings.

44. Road and street crossings must be constructed as shown on the standard plans and kept in good order.

45. Particular care must be taken to remove as far as practicable all obstacles which obstruct the view of crossing signs and approaching trains.

46. Flangeways must be kept clear of rubbish, snow, ice and other obstructions; defective crossing planks must be repaired promptly.

Platforms.

47. Station platform must be kept clean, free from rubbish, snow and ice, and in good order.

48. Defective platforms must be promptly repaired or reported.

Fences and Cattle-Guards.

49. Fences and gates along the right-of-way shall be kept in repair and all gates kept closed when they are not in actual use.

50. Cattle-guards must be kept in repair and at all times free from dirt, rubbish and other obstructions.

Track Jacks.

51. Track jacks must not be used between the rails of main tracks, except in unavoidable cases; the track must then be properly protected as in the case of other obstructions.

Rules Governing the Use of Stop and Cautionary Signals for the Protection of Unsafe and Obstructed Track.

Flagging.

52. In case of impassable track, flagging is the first duty, and repairs must wait, if necessary, until signals have been placed.

Flagging Before Obstructing Track.

53. The track must never be obstructed without first displaying stop signals not less than twenty (20) telegraph poles in each direction from the point of obstruction. Stop signals must be in the hands of reliable men. Flagmen must stop all trains and explain to the engineman the nature of the obstruction and its exact location.

Slow Orders.

54. When the track is not in condition for the passage of trains at the usual rate of speed, and this condition will continue over night or for the greater portion of the day, notice must be given immediately to the (Title) In such notices the place of danger,

.....

its nature and the speed at which trains may pass must be stated.

In addition to sending this notice, slow (color) signals must be displayed. When repairs have been made the person making them must at once notify the (Title) that the slow order

.....

may be recalled.

Signals to Be Used.

55. The color, hand, flag, lamp and engine steam whistle signals, and the train markers prescribed by and published in the Standard Code of the American Railway Association shall be used. (It is suggested that copies of the description and rules for the use of these signals, including diagrams, be inserted in books of rules governing maintenance of way employes.)

Time for Obstructing Track.

56. All work which will obstruct the track must be done at such times as will interfere as little as practicable with the pasage of trains.

Obstructing Track in Storm or Fog.

57. Except in case of emergency, no work that will obstruct the track shall be done during fogs or storms.

Signals in Obscure Weather.

58. In obscure weather, or on heavy grades or curves, extraordinary care must be taken to make sure that the stop signals are out a sufficient distance in both directions to insure full protection.

Proper Maintenance of Signals.

59. While working under the protection of signals, great care shall be taken that the signals are intact and in their proper location and position. Disregard of signals shall be promptly reported to the (Title)

.....

Signals for Double Track.

60. In using signals on double track, each track must be considered as a single track railroad upon which trains are likely to be run in either direction at any time.

RULES GOVERNING THE USE OF HAND, PUSH, MOTOR AND VELOCIPEDE CARS.

61. Care must be exercised by foremen and other employes in the use of hand, push, motor and velocipede cars. In order to avoid accident, they must protect themselves with the proper signals, when the view is obstructed. On moving hand cars at least one man must face the rear to look out for approaching trains.

62. Such cars must be protected from the weather and when not in use must be locked.

63. Cars must never be used or left on the main tracks or sidings unprotected. Loaded hand or push cars on the track are obstructions and must be protected by the proper signals.

64. They must not be attached to trains. When following trains, or other moving cars, they must not run closer than ten (10) rail lengths.

65. They must be kept in good order and inspected frequently for loose bolts or other defects.

66. Switches must not be thrown for such cars, unless loaded, and then only under the supervision of the foreman.

NEXT YEAR'S WORK.

For next year's work your Committee recommends that it be instructed to review the rules and instructions heretofore adopted by the Association and to recommend such changes and additions thereto as may seem desirable.

Discussion.

C. E. Lindsay (N. Y. C. & H. R. R.): I move that in each case the name of the supervisor of track, or the officer referred to, be substituted in the rules.

The motion was lost.

L. C. Fritch (C. G. W. R. R.): I suggest "state" be inserted in rule (18).

The President: The committee accepts that.

L. C. Fritch (C. G. W. R. R.): I suggest the use of the word "should" in (27), instead of "must."

The committee accepted the suggestion.

Earl Stimson (B. & O. R. R.): I suggest inserting "or widening of gage" in (27).

The committee accepted this suggestion also.

L. S. Rose (C. C. C. & St. L. Ry.): I move that part of (28) "gage kinks are as detrimental as low joints," be cut out.

The committee accepted a suggestion to change that wording to "Perfect gage is one of the essential features of good track, and should be maintained."

J. L. Campbell (E. P. & S. W. Ry.): I move the wording be changed to "Where tie plates are used, they shall be put on, etc."

L. S. Rose (C. C. C. & St. L. Ry.): I move that the second half of (28), referring to gage kinks be cut out.

The motion carried.

Rule (30), after some discussion, was adopted as read.

An amendment was offered to (31), suggesting "that the superelevation on curves be according to the standards of the American Engineering Association."

This amendment was adopted.

C. E. Lindsay (N. Y. C. & H. R. R. R.): I move the title of (32) be made "Switches and Frogs."

Motion carried.

Rule (34) was adopted with the addition of the words "and frogs" after "switches."

S. S. Roberts (I. C. R. R.): I move that rule (35) be amended to read, "Switch points must fit closely to the stock rail, and the stock rail must be bent to the standards" (referring to the track committee).

The motion carried.

A motion was passed to cut out (36) and (37).

G. J. Brooke (B. & O. R. R.): The committee received a communication from A. K. Shurtleff suggesting a change in (40), to read "Guard rail must be so placed that the distance from the frog point to the flange side of the guard rail shall be at least 4 ft. 6¾ ins., and

the distance from the flange side of the wing rail to the flange side of the guard rail shall not exceed 4 ft. 5 ins."

The committee accepted this reading and the paragraph was adopted.

C. E. Lindsay (N. Y. C. & H. R. R. R.): I suggest adding in (42) "signal posts."

The committee accepted the suggestion.

C. E. Lindsay (N. Y. C. & H. R. R. R.): I think (43) should read "Tools should not be left standing where they are liable to be struck by trains."

A rising vote was necessary for a decision, but the motion passed.

C. E. Lindsay (N. Y. C. & H. R. R. R.): I would suggest in (51), adding, "and then only under flag protection as outlined in (53)."

This was accepted by the committee.

C. E. Denny (L. S. & M. S. Ry.): I move that (53) be amended to read "the track must not be obstructed without first displaying stop signals in general accord with rule 99 of the American Railway Association," the balance of the rule to remain as it stands.

This motion was carried.

Minor changes were made in (57) and (58).

C. E. Lindsay (N. Y. C. & H. R. R. R.): I would like to suggest in (60) the wording be changed to "more than one track," instead of "double tracking."

The suggestion was accepted by the committee. Mr. Lindsay also suggested in (62) that the words "when left alone" replace "when not in use." This was also accepted.

In (66) a suggestion was made to specify "main line switches," and the committee accepted the change.

Hunter McDonald (N. C. & St. L. Ry.)—I move that (29) be re-opened and "uniform gage" be substituted for "perfect gage."

The motion carried.

SIGNALS AND INTERLOCKING.

A. H. Rudd, Chairman; L. R. Clausen, Vice-Chairman; Azel Ames, C. C. Anthony, H. Baker, H. S. Balliet, W. B. Causey, C. A. Christofferson, C. E. Denney, W. J. Eck, W. H. Elliott, M. H. Hovey, G. E. Ellis, A. S. Ingalls, J. C. Mock, F. P. Patenall, J. A. Peabody, W. B. Scott, A. G. Shaver, T. S. Stevens, H. H. Temple, Edwin F. Wendt, J. C. Young.

As a result of several years' study, the Committee, in 1907, arrived at the conclusion that the basis of a uniform system of signals should be the control of the train. During the succeeding two years the Committee, after exhaustive study and investigation of the subject, was unable to agree.

First—As to the number of indications that should be given by fixed signals;

Second—As to the wording of the indications;

Third—As to the aspects or forms of the signals that should be used to represent the several indications.

In 1910, the American Railway Engineering Association requested the American Railway Association to bring the matter to the attention of its Committee on Transportation for decision. The Committee on Transportation heard arguments at a meeting in June of that year and reported as follows:

"MEMORANDUM OF THE ESSENTIALS OF SIGNALING,

"Incorporated in the Report of the Committee on Transportation of the American Railway Association, May, 1911.

"The reports of various Committees of the Railway Signal Association and of the American Railway Engineering Association on the subject of signaling have been submitted to this Committee, with the request that the essentials of signaling be outlined or defined for the future guidance of their Committees.

"The subject has been carefully analyzed and considered. There are three signals that are essential in operation and therefore fundamental, viz.:

(1) Stop.
(2) Proceed with caution.
(3) Proceed.

"The fundamental, 'proceed with caution,' may be used with the same aspect to govern any cautionary movement; for example, when:

(a) Next signal is 'stop.'
(b) Next signal is 'proceed at low speed.'
(c) Next signal is 'proceed at medium speed.'
(d) A train is in the block.
(e) There may be an obstruction ahead.

"There are two additional indications which may be used where movements are to be made at a restricted speed, viz.:

(4) Proceed at low speed.
(5) Proceed at medium speed.

"Where automatic block system rules are in effect, a special mark of some distinctive character should be applied at the top signal.

"The Committee therefore recommends:

"Signal Fundamentals.

(1) Stop.
(2) Proceed with caution.
(3) Proceed.

Supplementary Indications to Be Used Where Required.

(4) Proceed at low speed.
(5) Proceed at medium speed.

"Stop signals operated under automatic block system rules should be designated by some distinctive mark to be determined by each road in accordance with local requirements."

(The Committee recommended symbols for standards, the same as adopted by the Railway Signal Association; published in *Railway Engineering*, November, 1912, pages 520 and 521.)

Conclusion.

That the signal indications and aspects and the means of designating stop signals operated under automatic block system rules, presented above, be adopted, published in the Manual and referred to the American Railway Association as information.

On Subject No. 2, "Report on the effect of treated and metal ties on track circuits," your Committee submits the following report:

REPORT.

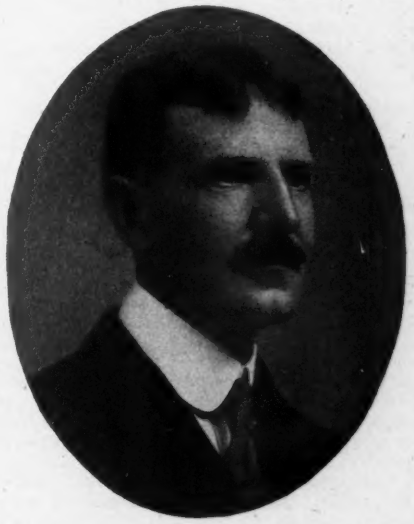
The effect of metal ties is self-evident. Each rail must be completely insulated from its ties to prevent a short circuit (similar to the action of the wheels and axle of a train).

Defective insulation at any point will cause leakage and defective insulation at both ends of only one tie will throw the track circuit out of service.

The effect of creosoted ties is not serious and, with alternating current track circuits, is negligible.

The effect of zinc treated ties is more problematical.

The response to the circular sent to all members on June 1 was most gratifying. One hundred and twenty-six replies were received, representing 92 railroads—many of them trunk lines. Sixty-nine of these use no zinc-treated ties; four use them to such a limited extent as to render a report valueless, including two which are making the first installation this year; seven use them extensively, but not where track circuits are in service; 12 only use them with track circuits, showing that, while the subject is decidedly important to these roads, it does not at the present time, in view of this small percentage, appear to be of great general interest; although, if it could be shown that this treatment did not affect circuits seriously, its use might be extended.



A. H. Rudd, Chairman Committee on Signals and Interlocking.

The following extracts from the reports show that their experiences differ very considerably, due, doubtless, in some measure, to different methods of treatment, but mainly to varying conditions of track, roadbed and especially ballast:

(a) "We are obliged to cut or relay all of our track sections which exceed one-half mile in length, owing to the combined leakage due to treated ties, metal in our ballast and brine drippings. With sections of this length we have no leakage trouble whatever, even on new lines where all of the ties are freshly treated.

"New zinc-treated ties undoubtedly increase the leakage at first, but the resistance seems to increase after they have been in service a year or so, and I do not think a 15 per cent annual renewal would cause serious trouble on any track circuit of reasonable length if the conditions are fairly good otherwise.

(b) "Where track circuits were in operation and renewals were made of some 15 or 20 ties in one location, there was a considerably greater leakage of track circuit current than ordinarily. We had a number of intermittent working track sections. For some time we could not imagine what the trouble was; when finally we did discover

it and improvements set in, in several cases the track circuits had to be shortened.

"It appears that in time the trouble diminished owing, as we believed to the zinc treatment disappearing from the surface of the tie.

(c) "From our experience the influence of 15 per cent, new zinc-treated ties on a track circuit is not appreciable; in fact, we have observed no trouble in some instances where track circuits 4,000 feet long have been installed on new second track completely equipped with zinc-treated ties, and where ballast and drainage conditions were good.

"On the other hand, we have found it necessary in some instances to take out zinc-treated ties and replace them with untreated ties where track circuit conditions were unusually bad, and the slight effect of zinc-treated ties was sufficient to overcome the safe operating margin.

(d) "A strange coincidence, however, was the fact that in those track circuits in which the resistance seemed relatively low to the proportion of treated ties the ties were not uniformly spaced throughout the distance, but were bunched together at only a few points in each such track circuit. This would seem to indicate that the effect of a number of treated ties spaced closely is greater than their aggregate effect when spaced with several untreated ties between each two treated ones.

"In our investigation we also observed the electrolytic action first observed by Mr. V. I. Smart, of the Illinois Central. It was noted that the resistance between the two rails, while very low immediately after the installation of a number of treated ties, became appreciably greater after the ties had been in service a short time, due apparently to the insulation of spikes on the positive side of the circuit by the formation of chloride of iron crystals.

(e) "However, if they are permitted to dry thoroughly before being placed, we have not had any bad effects.

"We find, if these ties are put in track immediately after treating or while they are wet, we experience some trouble with leakage in our track circuits.

(f) "We afterward found that we could eliminate this trouble by letting the ties season, and I am quite sure if ties treated with chloride of zinc would be seasoned, you could put in more than 15 per cent of them annually without interfering with the block signals.

"After the ties have been put in the track a sufficient length of time, even though they were not seasoned previously, the trouble will be eliminated.

"The experience on this road has been that where only a portion of the ties in a section are treated, it is necessary to use considerably more battery than where untreated ties are used.

"The track circuit gets better as the ties get older and in three or four years gets back to almost the same condition as if ties were untreated. In some cases where zinc-treated ties were used on this road, it was found necessary to reduce the length of track sections to 2,000 feet, and with these short sections we still experienced considerable trouble in damp weather.

"My general experience has been that it is a very hard matter to maintain a proper track circuit in sections where these zinc-treated ties were in use.

(g) "The peculiarity of this treatment is that it causes the most trouble on dry days, and apparently has very little, if any, effect on track circuits in cold or wet weather.

(h) "Where zinc-treated ties are used in all the renewals, and where from eight (8) to fifteen (15) per cent of the ties are renewed per year, no appreciable effect is produced on the track circuits.

"In cases where zinc-treated ties are laid continuously, I have found that the length of track circuits would have to be reduced about one-half.

(i) "The effect of the zinc was very noticeable, especially during wet periods. In fact the ties caused short circuits so that the signals would not work. The result was that we took out the zinc-treated ties and placed cypress ties. I do not know what per cent of the total number of ties were renewed, but it would appear that it was possible to ruin a circuit with a very few ties.

(j) "The ordinary yearly renewals of ties cause no trouble. However, I have experienced cases where on new track all of the ties being treated caused us a good deal of trouble for a period of two or three months. After this time, the leakage stopped, or at least there was not enough of it to prevent the track circuits working.

"My judgment is that where one is putting in track circuits on zinc-treated ties for new track, that the track section should be made somewhat shorter than otherwise would be necessary.

(k) "We have been using ties treated with chloride of zinc for the last four or five years, and our men advise that they cannot trace any track circuit trouble to the fact that the ties are treated with chloride of zinc. I presume we renew, as a rule, about 15 to 16 per cent, of our ties annually.

(l) "With these treatments ('Burnettizing' and 'Card' systems) we find that no difficulty is experienced with track circuits of 3,500 feet (our standard length), provided that no more than 15 per cent of treated ties is introduced in one season.

(m) "We have not many zinc-treated ties in our automatic territory, that is, not enough in any one spot to cause very much trouble. We had some trouble with some that were put in last year during the wet season, but it seems that this spring the trouble has disappeared, as we have had no failures on account of wet track so far.

(n) "In some of our zinc-treated ties, which were put in track before being properly seasoned, there was, for a shore time, some interference with the circuit, but as soon as the salt on the outside of the tie washed off, the trouble ceased. At no time was this trouble serious.

(o) "We have track circuits where practically every tie is treated with this process and find no leakage at all.

(p) "In support of my contention that each tie is a battery, I wish to state that we obtained readings of .003 volt and eight milamperes on one of the track circuits, with the track battery and relay disconnected. In other words, the ties alone were producing this much electrical energy. The spikes also appear to have a somewhat shiny surface, such as we would expect from a battery electrode. We are able to pick out all treated ties by means of a voltmeter, by taking readings between one of the rails and a spike driven at random in the tie. On an untreated tie in the track circuit we merely get a slight deflection of the voltmeter needle.

Summary.

The consensus of opinion is:

(1) That track circuits a mile in length are rendered inoperative by the extensive use of zinc-treated ties.

(2) That track circuits 2,000 feet in length may be operated successfully, even with 50 per cent or more of ties so treated.

(3) That 10 per cent to 15 per cent renewals a year will not materially affect such length circuits.

(4) That, where renewals are made of 15 or 20 adjacent ties, the leakage is much greater than where they are made singly at uniform distances, i. e., with 15 per cent renewals (every sixth or seventh tie).

(5) That, while the surface salts are present, more leakage occurs during wet weather than with untreated ties, as these wet salts form a better conductor than ordinary wet wood.

(6) That, in dry hot weather, the salts are drawn to the surface and constitute a more or less perfect conductor.

(7) That, after a period varying from three months to a year, these salts disappear and subsequently no interference is noticeable.

Conclusion.

That this report be received as information.

On Subject No. 3, "Economics in Labor of Signal Maintenance," your Committee begs to state that this subject is being considered with reference to the report in 1914.

Discussion.

The report was accepted as printed. The portion on effect of zinc chloride ties on track circuits, was submitted and accepted as information.

IRON AND STEEL STRUCTURES.

A. J. Himes, Chairman; O. E. Selby, Vice-Chairman; J. A. Bohland, A. W. Buel, Charles Chandler, C. L. Crandall, J. E. Crawford, J. E. Greiner, W. H. Moore, Albert Reichmann, C. C. Schneider, G. E. Tebbetts, L. F. Van Hagen, F. O. Dufour, C. E. Smith, I. F. Stern, E. E. Turneaure.

The subjects assigned to this Committee for investigation during the past year were:

(1) Report on Rules for Instruction and Guidance of Inspectors in Mill, Shop and Field.

(2) Report on Methods of Protection of Iron and Steel Structures Against Corrosion.

(3) Study the Design of Built-up Columns, co-operating with other investigators and committees of other societies.

These subjects were assigned to sub-committees, only one of which has made a final report. A meeting of the whole Committee was held in Buffalo on September 9, 1912, at which ten members were present.

A final report on Rules for Instruction and Guidance of Inspectors in Mill, Shop and Field, accompanied by a general descriptive statement of qualities desired in an inspector, is given in Appendix A. The report, with the descriptive statement omitted, is recommended for adoption and publication in the Manual.

Mr. Buel presented a minority report in Appendix B.

Mr. Schneider desires that the report be referred back to the Committee for further study.

Conclusions.

The recommendations of the Committee may be summarized as follows:

(1) That the report on Rules for Instruction and Guidance of Inspectors in Mill, Shop and Field be adopted and printed in the Manual.

(2) That the report of the Sub-Committee on the Design of Built-up Columns be received as a progress report.

APPENDIX A.—RULES FOR THE INSTRUCTION AND GUIDANCE OF INSPECTORS IN MILL, SHOP AND FIELD.

The duty of the inspectors is to guard the interests of his employer. These interests include: Safety of trains, persons and property; Quality of materials and workmanship; Correctness of construction; Economy.

Newly Elected Officers of the American Railway Engineering Association.

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A. K. SHURTLEFF, Office Engineer, Chicago, Rock Island & Pacific Railway, Chicago, Ill.

EARL STIMSON, Engineer Maintenance of Way, Baltimore & Ohio Railroad, Baltimore, Md.

JOHN G. SULLIVAN, Chief Engineer Western Lines, Canadian Pacific Railway, Winnipeg, Man., Canada.

Some of the means at his command for protecting these interests are: (1) The careful observance of such instructions as may be received from time to time. (2) Reports either received by him, as information concerning the status of the work at distant points, or prepared by him to exhibit the condition of the work under his immediate care. (3) Familiarity with the various means of communication between or among the several parties interested in the work and promptness in attending to messages and correspondence. (4) By recording daily, in a journal kept for that purpose, the facts concerning all events that may affect the relations between his employer and the contractor, his employer and the public, the contractor and the public. The term "public" is intended to include all third parties. The purpose of such a record is to aid in the settlement of disputes and claims that may arise because of or grow out of the work in hand.

The inspector should have some knowledge of bridge stresses and should be able to read drawings quickly and with accuracy. A knowledge of elementary mechanics and of the mechanics of materials will enable him to understand the reasons for many specifications and the ultimate effect of faults of various kinds. Some knowledge of those branches of bridge building with which he is not directly concerned will be of advantage to him in understanding the work of inspectors employed upon such work. A knowledge of detailed designing is often a help in meeting emergencies or overcoming unexpected difficulties. He should have such knowledge of the relations between the employer and his employes as will enable him to assist in maintaining harmony in the working force.

Temperamentally he should be judicial, diplomatic and not controversial. He should be deliberate in his consideration of new or unexpected conditions, but prompt and decisive in action. When making investigations and reports he should be thorough and exhaustive, in order that the person using the reports may act thereon intelligently and correctly. He should be studious in order that he may always be well informed concerning his work and on the alert to discover matters requiring special attention.

Some experience in business affairs will enable him to appreciate better than otherwise would be possible the relations between his employer and the contractor, and the necessity of maintaining harmony while at the same time securing the results desired.

An inspector's habits should be good, his honesty undoubted, and he should have a loyalty towards his employer that does not come from the payment of a salary.

It is too much to expect that any one inspector will have all of these qualifications. His value will, however. be measured by the degree and extent to which he does possess them. The salary which usually is paid an inspector is not sufficient to secure the services of a man who has acquired through development the qualities named, but we are sometimes fortunate enough to secure for inspectors men who are endowed by nature with such traits, and who have acquired experience through force of circumstances. A position which enables a man to hold the final word on constructions involving the expenditure of many thousands of dollars is one that can lack appreciation only when the employer is ignorant of its duties and the necessities from which they arise.

The inspector should be fully provided with the plans and specifications pertaining to the work. Often it is desirable that he should have masonry plans also in order that he may understand clearly the position which the structure is to occupy. He should have a copy of the contract or at least extracts therefrom covering those matters which might possibly need his attention. From time to time during the progress of the work he should be given special instructions covering its various phases. Should any further agreements or understandings be made or arrived at between the company which he represents and the contractor, he should be informed promptly concerning them. It does not inspire confidence in an inspector to leave him in the dark concerning matters which are within the scope of his work.

The character of the inspection will be determined to a large extent by the facilities offered. In a rolling mill it is not practicable for an inspector to witness all details of its operation. He must confine his efforts to the customary practice, seeking to learn all that he can of the subject, but not expecting or relying upon anything outside of the usual practice. Often it will happen that a wide-awake inspector will find much more work than it is possible for him to do. In such cases he should be given discretion in selecting the work to be given his first attention. He should then in the light of his own experience select those places where failures are most common and where, if failures do occur, the results are most serious.

Reports should be made at regular intervals defining the condition of the work and calling attention to matters of especial interest. Special reports should be made upon the happening of some event of more than ordinary interest. The amount of detail or the fulness of the regular reports should be governed by instructions. In general an inspector's time is more valuable when employed upon the site of the work where things are actually being done than in the office tabulating results. If a large amount of clerical work is required it is better to employ a clerk than to permit the inspector to perform duties which would keep him out of sight of the work which he is to inspect.

Instructions for the Mill Inspection of Structural Steel.

(1) Study the contract and specifications and secure such information concerning the proposed structure as will permit a full understanding of the use to be made of the various items of the order.

(2) Secure copies of the mill orders, shipping directions and other information concerning the material to be inspected.

(3) Attend promptly when notified of the rolling of material and so conduct the inspection and tests as not to interfere unnecessarily with the operations of the mill.

(4) Have the test specimens prepared and properly stamped with the melt numbers by the manufacturer. Observe the selection and stamping of specimens and verify the melt numbers when practicable.

(5) Attend and supervise the making of tensile, bending and drifting tests. Make sure that the testing machines are properly handled and that the specified speed of pulling is not exceeded. Note the behavior of the metal and check and record the results of the tests.

(6) Select the bars or other members for full-size tests as specified. Supervise such tests and check and record their results.

(7) Secure from the manufacturer records of the chemical analyses of the melts and accept only those in which the specified contents of impurities are not exceeded.

(8) Secure pieces of the test ingots and test specimens and have check analyses made outside of the manufacturers' laboratory when the analyses furnished by the manufacturer are erratic or for any other reason appear to be incorrect.

(9) Examine each piece of finished material for surface defects before shipment, requiring the material to be handled in a manner that will permit the examination to be thorough and complete. This inspection should detect evidence of excessive gagging or other injury due to cold straightening.

(10) Report promptly the shipment of any material from the mill, whose surface inspection has been waived. Such material should be examined by the shop inspector.

(11) Verify the section of all material by measurement and by weight.

(12) Study the operations of the plant and become familiar with the various processes of manufacture.

Cultivate the acquaintance of the mill employes and become familiar with their work so as to have direct knowledge of the mill practice and determine as well as the circumstances permit the correctness of the mill practice in so far as it is covered by the specifications.

(13) Record all tests and analyses on the forms provided.

(14) Keep informed as to the progress of the work in the shop and endeavor to secure the shipment of material at such times and in such order as to avoid delay in the fabrication.

(15) Secure copies of the shipping lists and compare them with the orders and make regular statements of the material that has been rolled and shipped.

(16) Make reports weekly or as may be directed, submitting complete records of tests, analyses and shipments and such other information as may be required.

Instructions for the Inspection of the Fabrication of Steel Bridges.

(1) Acquire a full knowledge of the conditions of the contract, such as the time of delivery, the railway company's actual need of the work, the desired order of shipment, and any special features in con-

nection with the delivery such as the position of the girders or truss members on cars at the bridge site.

(2) Study in advance the plans and specifications and see that all provisions thereof are complied with. These instructions are not to be construed as altering the specifications in any way.

(3) Endeavor to maintain pleasant relations with foremen and the workmen and by fairness, decisiveness and good sense interest them in the successful completion of the work.

(4) Attend constantly to the work, making inspection during the progress of the work in the shop, striving to keep up with the output in order that errors may be corrected before the work leaves the shop.

Conduct the inspection so as not to interfere unnecessarily with the routine operations of the shop.

(5) When unusual circumstances require an explanation of the plans or some variation from the specified procedure, take the necessary action promptly.

(6) Study the field connections, paying particular attention to clearances and making notations on the drawings so that they may be checked rapidly.

(7) Check all bevels and field rivet holes.

(8) Give careful attention to the quality of the workmanship, the condition of the plain material, accuracy of punching, care in assembling, alignment of rivets, tightness of rivets, accuracy of finishing of machined joints, painting and general finish.

(9) Make sure that reamed holes are truly cylindrical and that drillings are not allowed to remain between assembled parts.

(10) Watch for bends, kinks, and twists in the finished members and make certain that when leaving the shop they are in proper condition for erecting.

(11) Make sure that the webs of girders do not project beyond the flange angles and that the depth of web below the flange angles complies with the specification.

(12) Allow only the material rolled and accepted for the work to be used therein.

(13) Have the fabricated material shipped in the correct order for erection and in accordance with instructions, as far as practicable.

(14) Measure the width of each column and the lengths of all girders between columns when they are to be placed consecutively in a long row so as to insure that the columns and girders will not "build out" in erection so as to exceed the calculated length.

(15) Check "rights" and "lefts" and make sure that the proper number of each is shipped.

(16) Check base plates of girders before riveting and make sure that the bevel is not reversed.

(17) Check the space provided for driving field rivets, allowing sufficient space for the pneumatic riveter.

(18) Examine field connections after riveting to insure proper fitting and ease of erection.

(19) Make sure that shop splices are properly fitted and that matched and milled surfaces to transmit bearing are in close contact during riveting as specified.

(20) Examine and measure bored pinholes carefully to insure proper dimensions, spacing, and smoothness of finish.

(21) Measure the spacing center to center of the end connections for sections of I-beam floors or any similar construction in which the calculated spacing is liable to be exceeded because of the tendency of such work to "grow" as it is assembled.

(22) Make sure that stringers connecting to floor beams beneath the flange have sufficient clearance to care for their possible over-run in depth.

(23) Have the assembling trusses and girder spans required by the specifications carefully done and, in any case, if a large number of duplicate parts are to be made, insure the accuracy of field connections by having an occasional part assembled with its connecting member. The number of parts to be so assembled should be governed by the workmanship. If errors are found, a sufficient number of parts should be assembled to make it reasonably certain that such errors have been eliminated.

Have through girder spans with I-beam floors partially assembled and at least one bracket bolted in its final position.

Have at least one upper and lower shoe of each kind assembled and make sure that there is no interference.

(24) Make sure that iron templets used for reaming are properly set and held to line.

(25) Secure match-marking diagrams for work which has been assembled and reamed and make sure that the match marks are plainly visible.

(26) Have proper camber blocking used in assembling trusses and secure the desired camber before the reaming is done.

(27) Require that all treads and supports for the drums of draw spans be carefully leveled with an instrument.

(28) Study carefully the machine deails and discriminate between those dimensions which must be exact and those in which slight variations are permissible.

Determine in advance the desired accuracy of driving fits for bolts or keys and similar parts and make sure that such accuracy is attained.

(29) Examine castings carefully for blowholes and other imperfections and discriminate between such defects as are unimportant and those which render the castings unfit for use.

(30) Make sure that bushings, collars and similar parts are held securely in place.

(31) Make sure that all drum wheels, expansion rollers, turntable rollers and similar parts are exact in size, so as to carry equally the loads which may be placed upon them.

(32) Ascertain in advance that the paint provided complies with specifications. Watch carefully the painting directions and make sure that paint is properly applied and only where intended.

(33) Verify all shop marks and make sure that they are legible as well as correct.

(34) Have important members so loaded as to be headed in the right direction upon arrival at the site of the work.

(35) Try a few countersunk head bolts in the holes where they are to be used to insure a proper fit.

(36) Make sure that small pieces are bolted in place for shipment as shown on the plans and that other small parts are properly boxed or otherwise secured against loss.

(37) Make sure that rivets, tie rods, anchor bolts and miscellaneous parts are shipped so as to avoid delay in erection.

(38) Examine the field rivets to insure that they are free from fins or other defects.

(39) Exercise special care in the examination of all movable structures and particularly their moving parts.

(40) Make reports weekly as directed, exhibiting carefully and concisely the actual conditions.

(41) Observe carefully and report such unusual difficulties as may be encountered and the means adopted in overcoming them and endeavor by a study of the details or other means to make recommendations which will prevent their recurrence in future work.

Instructions for the Inspection of Bridge Erection.

(1) Study and observe the plans and specifications for steel construction. Study the masonry plans and check the masonry as built with the steel plans.

(2) Familiarize yourself with the local conditions affecting erection.

Make the acquaintance of the principal men engaged upon the work and of local residents whose interests may be affected thereby.

(3) Obtain and study carefully the employes' time table and be well posted concerning the time when regular and extra trains are due and their relative importance. Acquaint yourself with all special traffic arrangements made because of the work in hand.

(4) Secure full information concerning the conditions of the work in the bridge shop and the probable dates of shipment.

(5) Obtain reports of any uncompleted or erroneous work that must be attended to after arrival of the material in the field.

(6) Study the erection program in order to avoid delays and be able to recommend some other procedure in an emergency.

(7) Endeavor to have full preparations made before disturbing the track so that the erection may proceed rapidly and the period of such disturbance be made a minimum.

(8) Keep a record of the arrival of all materials. The contractor's record should be sufficient if available. Strive to anticipate any shortage of material and use all available facilities to hasten delivery of the needed parts.

(9) Study the progress of the work and determine whether it is likely to be completed in the time alloted. If not, endeavor to secure such additions to the force and equipment as will insure such completion.

(10) Make a daily record of the force employed and the distribution of labor, in a way that will assist in following clauses 9 and 23.

(11) Exercise a constant supervision of any temporary structure or falsework and make soundings if necessary with the purpose of discovering any evidence of failure or lack of safety and having it corrected before damage is done. Examine erection equipment with a view to its safety and adequacy.

(12) Be constantly on hand when work is in progress and note any damage to the metal, failure to conform to the specifications, or any especial difficulty in assembling.

(13) Make sure that each member of the structure is placed in its proper position. If match marks are used, examine them with care.

Endeavor to have the several members assembled in such order that no unsatisfactory makeshifts need be resorted to in getting some minor member in place.

(14) Prevent any abuse or rough usage of the material. Bending, straining and heavy pounding with sledges are included in such abuse.

(15) Watch carefully the use of fillers, washers and threaded members to see that they are neither omitted or misused.

(16) Make certain that all parts of the structure are properly aligned and that the required camber exists before riveting. It is possible for a structure to be badly distorted although the rivet holes are well filled with bolts.

(17) Watch the heating of rivets to insure against overheating and to make sure that scale is removed.

Examine and test carefully all field-driven rivets and have any that are loose or imperfect replaced.

Have cut out and replaced all rivets, whether shop-driven or field-driven, that may be loosened during erection and riveting.

Prevent injury to metal while removing rivets.

(18) Present to the contractora t once for his attention any violation of the specification or contract, and secure a correction or refer the matter to the proper authorities as soon as possible.

(19) Keep informed concerning the use of Company material and work trains and assist in procuring such material and trains when needed, and preserve a record thereof.

(20) Secure a match-marking diagram of any old structure to be removed and see that each part of such structure is properly marked in accordance therewith. Make a record of the manner of cutting the old structure apart and report any damage to the members of the placements as will be found necessary in re-erection.

(21) Secure photographic records of progress and the important features of the work wherever practicable.

(22) Make a record of all flagging of trains, whether performed for the benefit of the contractor or otherwise, delays to trains, personal injuries, and accidents of every kind.

(23) Make reports as directed, showing the progress of the work, the size of the force and the equipment in use.

Make a final report showing the cost of labor of erection per ton of material erected, the cost of labor per rivet in riveting, the cost of correcting errors in design and fabrication and commenting on the design and details: and give such other information as may be useful in planning similar work.

STUDY OF BUILT-UP COLUMNS.

The following report of Sub-Committee No. 3, Study of Built-up Columns, showing status of the preliminary work of the sub-committee to date, is respectfully submitted: The sub-committee was named by the chairman on June 4, 1912, and the chairman at once got into touch with the chairman and secretary of the American Society of Civil Engineers' Committee on Columns and Struts and ascertained the nature of the work being carried out under the direction of that committee so that no duplication of such work would be made by your sub-committee.

The chairman then took up with Mr. S. W. Stratton, Director of the Bureau of Standards, Washington, the question of the possibility of having several series of Column Tests made by the bureau in its new 2,300,000-lb. Emery machine then being installed. Director Stratton kindly agreed to have such series made and agreed to begin the tests as soon as the machine was in commission. A light and a heavy section of eight sections is to be made up in lengths giving three l/r ratios (50, 85 and 120) and three specimens of each column to be fabricated, making in all one hundred and forty-four (144) test columns.

The detail drawings were made up by Mr. J. E. Crawford, member of the sub-committee, and presented to the general committee for discussion at its meeting in Buffalo on September 9, 1912. Ten members having expressed their satisfaction with this preliminary series, with some minor modifications, the chairman went to Washington on October 18th and arranged with Director Stratton and Mr. J. E. Howard to have the eighteen (18) columns representing Column No. 1, Series No. 1, at once fabricated and the tests commenced as soon as the final adjustments of the weighing apparatus were completed. Before ordering the fabrication of the remaining columns of Series No. 1, the committee will examine the results of the first eighteen (18) tests representing Column No. 1 and will probably then proceed with a sub-series on this column, changing one variable at a time in order to determine the best arrangement of details for the section.

(Signed.) W. H. MOORE, *Chairman Sub-Committee No.* 3.

An abstract of Appendix B., will be published in a later issue.

Discussion.

A. J. Himes, chairman.—The subject of third rail clearance is under consideration, and the change suggested in the diagram will probably be made. Provision has been made for a joint committee to investigate this subject, consisting of two members from each of the following: Committee American Railway Engineering Association; Railway Signal Association; Commitee X, American Railway Engineering Association. The committee recommends the following subjects for future investigation: Methods of protecting iron and steel structures against corrosion; design of built-up columns; secondary stresses; protection of traffic at movable bridges; revision of the bridge clearance diagram; standard specifications for phosphor bronze; riveted joints, and locomotive turntables.

W. R. Edwards (B. & O. R. R.)—I do not think (9) should stand, as it cannot be complied with under present conditions.

Chairman.—If necessary, surface inspection can be made after shipment.

O. E. Selby (C. C. C. & St. L. Ry.)—In answer to the question as to meaning of "Camber is not reversed." There is a liability of the top flange and the lower flange becoming mixed, and bottom plates might be riveted to the top.

T. Earle (Penn. Steel Co.)—I suggest "bevel" be used instead of "camber," which will make the meaning clear.

The committee accepts the suggestion.

A suggestion was accepted by the committee to change the reading of (23) to "Examine and measure bored pin holes carefully to insure proper position, dimension, and spacing, and smoothness of finish.

C. H. Cartlidge (C., B. & Q. R. R.)—I move this paragraph be referred back to the committee for further consideration, as it calls for something which should be covered in the specifications.

The motion carried.

A. W. Carpenter (N. Y. C. & H. R. R. R.)—I suggest "driving" be omitted, as a driving fit is a definition of accuracy in itself.

The committee accepted the suggestion.

A. W. Carpenter (N. Y. C. & H. R. R. R.)—I think a clause should be added specifying "check dimensions of all material used in each member." I make a motion to adopt this additional clause.

O. E. Selby (C. C. C. & St. L. Ry.)—Clause (8) covers that suggestion.

Mr. Carpenter's motion was put to vote and was carried.

A. W. Carpenter.—We usually scrap old structures. I would suggest in (20) we insert after "removed," the words, "which it is desired to re-erect." If the structure is not re-erected the instructions would mean a waste of time.

The committee accepted the suggestion.

Mr. Carpenter also suggested a clause "see that bent members are straightened."

The entire set of instructions, with the exception of (23), was put to vote and passed.

J. B. JENKINS, *Chairman;* G. J. RAY, *Vice-Chairman.*

Each of the three subjects assigned to your Committee was reassigned to a sub-committee of eight members.

The work of the year was characterized by the keen interest

J. B. Jenkins, Chairman Committee on Track.

manifested in all subjects under consideration, particularly in the subject of economics in track labor.

In addition to the work assigned, your Committee has supplemented and completed the Table of Functions of the Ten-Chord Spiral on pp. 102-110 of the Manual.

(1) GENERAL SPECIFICATIONS FOR TRACK BOLTS, NUT-LOCKS, TIE-PLATES, COMMON AND SCREW TRACK SPIKES.

G. J. Ray, chairman; Geo. H. Bremner, Garrett Davis, Raffe Emerson, E. G. Ericson, T. H. Hickey, J. R. Leighty and W. G. Raymond, Sub-Commitee.

Your Committee presents statements of general principles to be followed in the design and manufacture of tie-plates, track bolts and anti-creepers and specifications for steel tie-plates, malleable tie-plates, wrought-iron tie-plates, track bolts, spiral spring nutlocks, ordinary track spikes and screw spikes.

Tie-Plates.

General Principles to Be Followed in the Design.

The plates shall not be less than six (6) inches in width, and as much wider as consistent with the class of ties to be used.

The length of plates shall not be less than the safe bearing area of the ties divided by the width of the plate, and, when made for screw spikes, shall be so shaped as to provide proper support for the screw spikes.

They shall not be less than five-eighths (⅝) of an inch thick along either edge of the base of the rail.

The thickness of the plate shall be properly proportioned to the length.

The plates shall have a shoulder at least one-half (½) of an inch high. The distance from the edge of rail base to the end of the tie-

plate on the outer side must be uniform, and in excess of the projection inside of the rail base.

Where treated ties are used or where plates are for screw spikes, a flat bottom plate is preferable. Where ribs of any kind are used on base of plate, these shall be few in number and not to exceed one-quarter (¼) of an inch in depth.

The punching must correspond to the slotting in the splice bars and, where advisable, may be so arranged that the plates may be used for joints. Spike holes may be punched for varying widths of rail base where the slotting will permit such punching without the holes interfering with each other and when the plate is of such design that the additional holes will not impair the strength of the plate.

Specifications for Steel Tie-Plates.

Material.—The plates shall be made of Bessemer or open-hearth steel.

Physical Properties and Tests.—The tie-plates shall conform to the following requirements:

Ultimate strength, not less than 55,000 lbs.
Elastic limit, not less than 50 per cent. of ultimate strength.
Elongation, not less than 20 per cent. in 2 inches.
Reduction of area, not less than 40 per cent.

Plates shall bend cold for 90 degrees without showing any sign of fracture.

A sufficient number of tests will be made to satisfy the inspector that the material meets the specifications in every respect.

Workmanship and Finish.—Subject to the following allowances, the form and dimensions of the plates shall conform to the drawings submitted to the manufacturer.

The length and width shall not vary more than one-eighth (⅛) of an inch from the dimensions shown.

The thickness shall not vary more than one thirty-second (1-32) of an inch from the dimensions shown.

All variations in length shall be left on the inside end of the plate.

The distance from the shoulder to the outside end of the plate must be made uniform.

The spike holes must be punched from the top, clean cut, without burrs, and the plates must not be cracked or bent out of shape in punching the holes.

All plates must be stamped on the top side, outside of the base of rail, with the section and weight of rail.

The plates shall be free from burrs and imperfections.

Inspection.—When required, the manufacturer shall furnish samples of tie-plates from a preliminary rolling before proceeding with the filling of the order and give sufficient notice in advance of the date when they will be ready for inspection.

The inspector representing the purchaser shall have free entry at all times, while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered.

The inspection shall be made at the mill and the manufacturer shall afford the inspector free of cost all reasonable facilities to satisfy himself that the plates are being furnished in accordance with these specifications. The tests and inspections shall be so conducted as not to interfere unnecessarily with the operation of the works.

Tests shall be made of samples of the finished product selected by the inspector from each lot of fifty bundles. Two pieces shall be selected for each test and if both meet the requirements of the specifications the lot will be accepted. If one of the test pieces fails a third test piece shall be selected and tested; if it meets the requirements of the specifications the lot will be accepted, but if it fails the lot will be rejected.

If, after shipment, any tie-plates are found to be defective due to material or manufacture, they may be rejected.

Shipping.—Tie-plates shall be wired together in bundles, the weighing not to exceed 100 lbs., and shipped with a uniform number in each bundle.

Specifications for Wrought-Iron Tie-Plates.

Material.—The plates shall be made of wrought-iron.

Physical Properties and Tests.—The ultimate strength shall be not less than 45,000 lbs.

Plates shall bend cold for 90 degrees without showing any sign of fracture.

A sufficient number of tests will be made to satisfy the inspector that the material meets the specifications in every respect.

Workmanship and Finish.—Subject to the following allowances, the form and dimensions of the plates shall conform to the drawings submitted to the manufacturer.

The length and width shall not vary more than one-eighth (⅛) of an inch from the dimensions shown.

The thickness shall not vary more than one thirty-second (1-32) of an inch from the dimensions shown.

All variations in length shall be left on the inside end of the plate.

The distance from the shoulder to the outside end of the plate must be made uniform.

The spike holes must be punched from the top, clean cut, without burrs, and the plates must not be cracked or bent out of shape in punching the holes.

All plates must be stamped on the top side, outside of the base of rail, with the section and weight of rail.

The plates shall be free from burrs and imperfections.

Inspection.—When required, the manufacturer shall furnish samples of tie-plates from a preliminary rolling before proceeding with the filling of the order and give sufficient notice in advance of the date when they will be ready for inspection.

The inspector representing the purchaser shall have free entry at all times, while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered.

The inspection shall be made at the mill and the manufacturer shall afford the inspector free of cost all reasonable facilities to satisfy himself that the plates are being furnished in accordance with these specifications.

These tests and inspections shall be so conducted as not to interfere unnecessarily with the operation of the works.

Tests shall be made of samples of the finished product selected by the inspector from each lot of fifty bundles. Two pieces shall be selected for each test and if both meet the requirements of the specifications the lot will be accepted. If one of the test pieces fails a third test piece shall be selected and tested; if it meets the requirements of the specifications the lot will be accepted but if it fails the lot will be rejected.

If after shipment, any tie-plates are found to be defective due to material or manufacture, they may be rejected.

Shipping.—Tie-plates shall be wired together in bundles, the weight not to exceed 100 lbs., and shipped with a uniform number in each bundle.

Specifications for Malleable Tie-Plates.

Material.—The plates shall be made from furnace malleable iron.

Physical Properties and Tests.—All plates must be cast with a lug for test purposes. The test lug when broken off must not break easily, as cast-iron, but must bend and show signs of toughness. The fracture must show a narrow band of white metal on the surface, center portion being dark and fibreless.

The plates must bend sufficiently to show through annealing.

A sufficient number of tests will be made to satisfy the inspector that the material meets the specifications in every respect.

Workmanship and Finish.—Subject to the following allowances, the form and dimensions of the plate shall conform to the drawings submitted to the manufacturer.

The length and width shall not vary more than one-sixteenth (1/16) of an inch from the dimensions shown.

The thickness shall not vary more than one thirty-second (1-32) of an inch from the dimensions shown.

All plates must be properly and thoroughly annealed.

All plates must be well cleaned and free from warping, shrinkage cracks, blow holes, fins, and other imperfections.

Inspection.—When required, the manufacturer shall furnish samples of tie-plates from a preliminary lot before proceeding with the filling of the order and give sufficient notice in advance of the date when they will be ready for inspection.

The inspector representing the purchaser shall have free entry at all times, while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered.

The inspection shall be made at the mill and the manufacturer shall afford the inspector free of cost all reasonable facilities to satisfy himself that the plates are being furnished in accordance with these specifications.

These tests and inspections shall be so conducted as not to interfere unnecessarily with the operation of the works.

If after shipment, any tie-plates are found to be defective due to material or manufacture, they may be rejected.

Shipping.—Tie-plates shall be wired together in bundles, not to exceed 100 lbs., and shipped with a uniform number in each bundle.

Track Bolts.

Facts and General Principles to Be Taken Into Consideration in the Design.

As a rule, as large track bolts should be used as the rail and splice bars will permit.

Bolts with rolled threads show a greater ultimate strength than those of the same size with cut threads. The elastic limit, however, is not materially different.

A workman pulling on a 33-inch wrench with a pull of 100 lbs. will load a ⅞-inch diameter bolt to the extent of 45,000 lbs. per square inch where the threads are in average condition. Therefore, it is easy to see how a bolt with a low elastic limit will readily be stretched in being tightened.

A ⅞-inch bolt with an elastic limit of 45,000 lbs. will require the same pull to stretch it as a 1-inch bolt with an elastic limit of 35,000 lbs. Again, a 1-inch bolt with an elastic limit of 75,000 lbs.

requires over twice the pull to stretch it as a 1-inch bolt with an elastic limit of 35,000 lbs.

Specifications for Track Bolts and Nuts.

Material.—Steel shall be made by the open-hearth or other approved process. If necessary to secure the properties desired the bolts may be heat treated.

Physical Properties and Tests.—The bolts shall conform to the following requirements:

For carbon steel
- Elastic limit not less than 35,000 lbs. per sq. in.
- Elongation, not less than 25 per cent. in 2 inches.
- Reduction of area, not less than 50 per cent.

For untreated nickel or other alloy steel
- Elastic limit, not less than 45,000 lbs. per sq. in.
- Elongation, not less than 20 per cent. in 2 inches.
- Reduction of area, not less than 40 per cent.

For heat treated nickel or other alloy steel
- Elastic limit, not less than 75,000 lbs. per sq. in.
- Elongation, not less than 15 per cent. in 2 inches.
- Reduction of area, not less than 40 per cent.

Elastic limit shall in no case be less than 50 per cent. of the ultimate strength.

The elastic limit, elongation and reduction of area may be determined on a test piece ½x2 in. turned from a finished bolt.

The ductility of the bolts shall be determined by the cold bend test, which requires that the material used in the bolts shall bend cold through 180 degrees and flatten itself without fracture on the outside of the bent portion. This bend may be made on the unthreaded portion of a finished bolt, on a blank bolt or on a test piece of the same same size and same grade of steel, in any case, subjected to the same treatment as the finished bolt. It is not necessary that the bolt bend double in the threaded portion.

A sufficient number of tests shall be made to satisfy the inspector that the material meets the specifications in every respect.

Workmanship and Finish.—Subject to the following allowances, track bolts shall conform to the drawings submitted to the manufacturer.

The length shall not be more than one-sixteenth (1/16) of an inch less or one-eighth (⅛) of an inch more than the dimensions shown.

The diameter of the bolt shall not vary more than one sixty-fourth (1-64) of an inch from the dimensions shown.

The size of the head shall not vary more than one-sixteenth (1/16) of an inch from the dimensions shown.

The outside dimensions of the nut shall not vary more than one-thirty-second (1-32) of an inch from the dimensions shown.

The shoulder of the bolt shall not vary more than one sixty-fourth (1-64) of an inch from the dimensions shown.

The heads and nuts shall be free from checks or burrs of any kind. They shall have the U. S. Standard upset thread unless otherwise specified. The threads may be either cut or rolled and shall be full and clean, with not less than two, nor more than five, finger threads.

Inspection.—When required, the manufacturer shall furnish samples of bolts from a preliminary rolling before proceeding with the filling of the order and give sufficient notice in advance of the date when they will be ready for inspection.

The inspector representing the purchaser shall have free entry at all times, while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered.

The inspection shall be made at the mill and the manufacturer shall afford the inspector free of cost all reasonable facilities to satisfy himself that the bolts are being furnished in accordance with these specifications. Tests and inspections shall be so conducted as not to interfere unnecessarily with the operation of the works.

Tests shall be made of samples of the finished product selected by by the inspector from each lot of 100 kegs. Two pieces shall be selected for each test and if both meet meet the requirements of the specifications the lot will be accepted. If one of the test pieces fails a third test piece shall be selected and tested; if it meets the requirements of the specifications the lot will be accepted, but if it fails the lot will be rejected.

If, after shipment, any bolts are found to be defective due to material or manufacture, they may be rejected.

Marking and Shipping.—When the bolts are shipped they shall have the nuts applied for at least two threads, shall be properly oiled to prevent rusting and shall be packed in serviceable kegs. All kegs must be plainly marked as to material, size of bolts and name of manufacturer.

Specifications for Spiral Spring Nutlocks.

Material.—The steel from which the nutlocks are made must be of open-hearth steel, or other approved process, and shall conform to the following chemical analysis:

Phosphorous, not over .05 per cent.
Sulphur, not over .05 per cent.

Physical Properties and Tests.—After the finished nutlock has been subjected to pressure sufficient to compress it flat for a period of one hour, its reaction shall not be less than two-thirds its height or thickness of section, providing thickness is less than width of section. If the section is square, the reaction must not be less than one-half its thickness. If height or thickness of section is more than its width, reaction shall be not less than the width of the section.*

*Note.—The internal diameters naturally affect the percentage of reaction, and the above specifications apply to nutlocks of internal diameters from 13-16 of an inch to 1 5-16 inches. Owing to the difficulty of establishing a common rate of percentage that shall be uniformly applicable to any internal diameter of any nutlock of any section, it has been sought to cover the matter as above. Amount and durability of reactionary power under constant pressure is the true test of any spiral spring nutlock. The percentage of reaction increases proportionately with the increased internal diameter of any given section.

With one end of the finished nutlock secured in a vise, and the opposite end twisted to 45 degrees, there must be no sign of fracture. When further twisted until broken, the fracture must show a good quality of steel.

A sufficient number of tests will be made to satisfy the inspector that the material meets the specifications in every respect.

Workmanship and Finish.—The dimensions and form of the nutlock shall conform to the drawings submitted to the manufacturer.

The nutlocks shall be clean, without burrs or rough edges. The coil and cross section shall be uniform throughout.

The manufacturer is required to guarantee:

First. That the steel was thoroughly annealed and permitted to assume its proper molecular structure before being made into nutlocks.

Second. That the subsequent heat treatment was scientifically accurate according to the best methods known, to secure uniformity of temper and the highest efficiency attainable.

Inspection.—When required, the manufacturer shall furnish samples of nutlocks from a preliminary lot before proceeding with the filling of the order, and give sufficient notice in advance of the date when they will be ready for inspection.

The inspector representing the purchaser shall have free entry at all times, while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered.

The inspection shall be made at the mill and the manufacturer shall afford the inspector free of cost all reasonable facilities to satisfy himself that the nutlocks are being furnished in accordance with these specifications. The tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

Tests shall be made of samples of the finished product selected by the inspector from each separate heat treatment. Two pieces shall be selected for each test and if both meet the requirements of the specifications the lot will be accepted. If one of the test pieces fails a third test piece shall be selected and tested; if it meets the requirements of the specifications the lot will be accepted, but if it fails the lot will be rejected.

If after shipment, any nutlocks are found to be defective due to material or manufacture, they may be rejected.

Marking and Shipping.—When the nutlocks are shipped they shall be packed in good serviceable boxes. All boxes must be plainly marked as to material, size and number contained therein, and the name of the manufacturer.

Specifications for Ordinary Track Spikes.

Material.—Steel shall be made by the open-hearth or other approved process. If necessary to secure the properties desired, the spikes may be heat treated.

Physical Properties and Tests.—The spikes shall conform to the following requirements:

- Ultimate strength, not less than 55,000 lbs.
- Elastic limit, not less than 50 per cent. of ultimate strength.
- Elongation, not less than 20 per cent. in 2 inches.
- Reduction of area, not less than 40 per cent.

The finished spike, when bent back on itself through 180 degrees and hammered down, shall show no signs of fracture.

When the head of the spike is bent backward cold it shall show no signs of fracture.

When the body of the spike is twisted cold one and one-half (1½) turns it shall show no signs of fracture.

A sufficient number of tests will be made to satisfy the inspector that the material meets the specifications in every respect.

Workmanship and Finish.—Subject to the following allowances, the form and dimensions of the spike shall conform to the drawings submitted to the manufacturer.

The thickness shall not vary more than one thirty-second (1-32) of an inch from the dimensions shown.

The length shall not be less, nor over one-quarter (¼) of an inch more, than the dimensions shown.

The thickness of the head shall not vary more than one-sixteenth (1/16) of an inch from the dimensions shown.

The angle of the hook shall not vary more than one degree from that shown on the drawing.

The spikes must be neatly formed, free from burrs and rough edges, and have well-shaped heads and sharp points.

Inspection.—When required, the manufacturer shall furnish samples of spikes from a preliminary rolling before proceeding with the filling of the order and give sufficient notice in advance of the date when they will be ready for inspection.

The inspector representing the purchaser shall have free entry at all times, while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered.

The inspection shall be made at the mill and the manufacturer shall afford the inspector free of cost all reasonable facilities to satisfy himself that the spikes are being furnished in accordance with these specifications. The tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

Tests shall be made of samples of the finished product selected by the inspector from each lot of 100 kegs or bags. Two pieces shall be selected for each test and if both meet the requirements of the specifications the lot will be accepted. If one of the test pieces fails a third test piece shall be selected and tested; if it meets the requirements of the specifications the lot will be accepted but if it fails the lot will be rejected.

If, after shipment, any spikes are found to be defective due to material or manufacture, they may be rejected.

Marking and Shipping.—When the spikes are shipped they shall be packed in good serviceable kegs or bags. All kegs or bags must be plainly marked as to material, size of spikes and name of manufacturer.

Specifications for Screw Spikes.

Material.—Screw spikes shall be made of open-hearth steel.

The chemical properties of the finished spike shall conform to the following limits:

Phosphorous, not over .05 per cent.
Sulphur, not over .05 per cent.

Physical Properties and Tests.—The finished spike shall conform to the following requirements:

Ultimate strength, not less than 60,000 lbs. per sq. in.
Elastic limit, not less than 50 per cent. of ultimate strength.
Elongation, not less than 22 per cent. in 2 inches.
Reduction of area, not less than 40 per cent.

The material used in the spikes when bent cold through an angle of 180 degrees and hammered down shall show no signs of fracture.

The finished spike when bent cold through an angle of 90 degrees shall show no sign of fracture.

A sufficient number of tests will be made to satisfy the inspector that the material meets the specifications in every respect.

Workmanship and Finish.—The dimensions and form of the screw spike shall conform to the drawings submitted to the manufacturer.

All spikes shall be finished smooth and in a workmanlike manner, having no rough edges. They shall be of exact size, with symmetrical heads the axis of which must be situated in the direct line of the shank axis produced.

Inspection.—When required, the manufacturer shall furnish samples of spikes from a preliminary rolling before proceeding with the filling of the order and give sufficient notice in advance of the date when they will be ready for inspection.

The inspector representing the purchaser shall have free entry at all times, while the work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered.

The inspection shall be made at the mill and the manufacturer shall afford the inspector free of cost all reasonable facilities to satisfy himself that the spikes are being furnished in accordance with these specifications. The tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

Tests shall be made of samples of the finished product selected by the inspector from each lot of 100 kegs or bags. Two pieces shall be selected for each test and if both meet the requirements of the specifications the lot will be accepted. If one of the test pieces fails a third test piece shall be selected and tested; if it meets the requirements of the specifications the lot will be accepted, but if it fails the lot will be rejected.

If after shipment, any spikes are found to be defective due to material or manufacture, they may be rejected.

Marking and Shipping.—When the spikes are shipped they shall be properly oiled to prevent rusting and shall be packed in good serviceable kegs or bags. All kegs or bags must be plainly marked as to material, size of spike and name of manufacturer.

Anti-Creepers.

General Requirements to Be Met in the Design and Manufacture.

They shall be so designed as to fit two or more different weights of rail and show that they can be readily removed and re-applied.

They must be easy to apply under full-ballasted track.

They must be substantial enough to stand driving to place without chance of breaking.

The least possible number of movable parts is desirable.

When applied they must be in position rigidly enough to carry the tie with them in any kind of ballast without slipping.

They shall be made with sufficient take-up to permit of proper tightening.

They must not loosen when in place, or sufficiently to slip when the rail slacks back.

Controlling or delicate parts should be made of non-rustable material.

Anti-creepers made of steel shall be of sufficient size to minimize the destruction by rust.

Anti-creepers made of malleable iron must be from furnace malleable iron properly annealed, and of sufficient weight to prevent breakage and distortion in application or in service.

(2) CONTINUE STUDY OF DESIGN OF MAIN LINE TURNOUTS.

H. T. Porter, Chairman; A. Bruner, Thomas Maney, Curtiss Millard, R. M. Pearce, S. S. Roberts, A. H. Stone and C. C. Wentworth, Sub-Committee.

Your Committee presents typical plans illustrating recommended designs for Nos. 8, 11 and 16 main line turnouts.

In addition, your Committee has secured data as to the height of center of gravity of locomotives and tenders recently constructed and has under way a table showing the speed at which trains may be run through various turnouts and various curves with different elevations of outer rail, for publication as a matter of information. This information is not yet in shape for submission.

Your Committee has also begun the preparation of typical plans for cross-overs.

(3) ECONOMICS IN TRACK LABOR.

H. R. Safford, Chairman; J. M. R. Fairbairn, E. T. Howson, P. C. Newbegin, L. S. Rose, C. H. Stein, F. S. Stevens and W. J. Towne, Sub-Committee.

Your Committee adopted the following preliminary outline for future study, the plan being comprehensive and intended to cover the work of several years:

A system of reports to measure efficiency of gangs for various kinds of work and efficiency of various kinds of labor with a view to establishing tangible data to correctly measure efficiency.

A system of reports to establish unit costs of work.

The use of a system of work cards and other means of planning work and keeping records to measure progress.

The development of a plan and system for establishing a thoroughly accurate basis of comparison of track conditions as a means for measuring efficiency—equating for various conditions, such as rails, ballast, ties, drainage, length of track, etc.

A study of the use and efficiency of motor cars for track work.

A study of labor-saving devices.

A study of the method best suited to various kinds of track work, particular reference being made to rail, ballast and tie renewals.

A study of the method of renewing ties, as to renewal of ties on every mile of track each year or taking a portion of the track each year to avoid disturbing track too often.

A study of the matter of proper season for various kinds of track work.

A study of the organization best suited to carry on the above work as to extra gangs versus section gangs.

A study of the general suggestion to combine under section foremen such work as ordinary maintenance of signals and telegraph lines, rough carpentry, water station repairs, etc.

Proper size of track supervisor's territory.

The establishment of a labor bureau to better control and secure labor.

Training laborers for track work by specially organized gangs for that purpose.

Rates of pay for section labor.

The matter of obtaining good section foremen.

The education of section foremen.

The rates of pay of section foremen.

The proper basis for providing section houses.

The subjects chosen for immediate investigation were:

(1) The matter of educating and securing section foremen.

(2) Method of making program of work and sequence of work.

Two circulars were prepared and submitted to the membership by the Secretary of the Association, dealing with these subjects.

A great deal of information has been received upon many features, some of which enables the Committee to reach a conclusion with reference to certain matters, and in other instances the information furnished is not in sufficient detail to enable a conclusion to be reached at this time, and these matters will be the subject of further research.

Your Committee wishes to express its appreciation of the response which met the requests for information. Practically all the replies were promptly and fully made and too voluminous to repeat in this report. The summary, however, contains a concise expression of the important points brought out in these letters; the replies to questions "A," "C" and "D," bearing upon the recommendation of your Committee and to questions "B" and "J," which are considered important as a matter of information, are transmitted herewith.

Eighty-seven replies were received to this circular, and the following represents the summary of the information received:

Questions "A" and "C": "A" Has your Company in effect any plan for systematic education of men to fill places of section foremen?

"C" Do you have any defined plan of equipping gangs with apprentices and assistant foremen?

Of the total replies received

57 indicated no plan in effect.
23 reported the practice of employing assistant foremen.
6 reported the practice of employing apprentices.
1 reported the use of a "school gang" for the education of foremen.
1 reported no information.
2 reported the practice of using both assistant foremen and apprentices.

Question "D": Do you have any defined plan of educating foremen as a class by instruction, such as educational bureaus, periodical meetings, etc.?

Of the replies received

72 indicated no defined plan of education.
10 reported the practice of periodically instructing men through meetings.
3 reported the use of educational bureaus.
1 reported education by pamphlet, and
1 reported education by inspection trips to other roads.

Question "B": From what classes of men do you now select foremen?

The intent of this question was to develop to what extent selections were made for foremen from certain nationalities or classes of labor, but the information received is quite general and not sufficiently specific to enable the sub-committee to give a very accurate opinion upon this matter, and this is to be made the subject of further research with a view to determining,

(1) The relative efficiency of various classes or nationalities.

(2) Information showing the number of each nationality employed.

(3) Their qualifications as to (a) honesty, (b) reliability, and (c) general efficiency.

(4) The effect, in employing foreigners for section foremen, in improving the supply of labor for ordinary section work with a view to overcoming the difficulties now existing in foreign labor desiring to work generally in large gangs.

Question "J": What percentage of your foremen are foreign born?

25 report none employed.
27 report 25 per cent. or less.
16 report 50 per cent. or less.
8 report 75 per cent. or less.
7 report 100 per cent. or less, and
4 give no information.

After a complete consideration of these replies, your Committee is led to recommend the following as desirable agencies to obtain a better class of section foremen:

(a) The application of the principle of apprenticeship for a defined period during which the rate of pay shall be the same as a laborer, following which those men who show the necessary qualities for foremanship to be given an increase in compensation and the title of assistant foreman. From this position these men should be promoted to that of section foreman.

(b) The application of a method of education by periodical instruction in the form of meetings, at which supervising officers should instruct as to practice and encourage discussion between the men.

(c) The application where possible of an educational system, such as is being conducted on several of the larger railways, for which articles are written by supervising officers dealing with the best practices, which articles are printed and sent to foremen and assistant foremen, free of cost, following which an examination is conducted and promotion depending upon results of such examinations.

Conclusions.

Your Committee recommends for adoption and publication in the Manual:

1. As representing good practice:
   (a) Tie Plates—General principles to be followed in the design.
   (b) Specifications for Steel Tie Plates.
   (c) Specifications for Wrought Iron Tie Plates.
   (d) Specifications for Malleable Tie Plates.
   (e) Track Bolts—Facts and general principles to be taken into consideration in the design.
   (f) Specifications for Track Bolts.
   (g) Specifications for Spiral Spring Nutlocks.
   (h) Specifications for Ordinary Track Spikes.
   (i) Specifications for Screw Spikes.
   (j) Anti-Creepers—General requirements to be met in the design and manufacture.
2. As representing good practice:
   Typical plans of Nos. 8, 11 and 16 main line turnouts.
3. As desirable agencies to obtain a better class of section foremen:
   (a) The application of the principle of apprenticeship for a defined period during which the rate of pay will be the same as a laborer, following which those men who show the necessary qualities for foremanship to be given an increase in compensation and the title of assistant foreman. From this position those men should be promoted to that of section foreman.
   (b) The application of a method of education by periodical instruction in the form of meetings, at which supervising officers should instruct as to practice and encourage discussion between the men.
   (c) The application where possible of an educational system, such as is being conducted on several of the larger railways, for which articles are written by supervising officers dealing with the best practices, which articles are printed and sent to foremen and assist foremen free of cost, following which an examination is conducted and promotions depending on the results of such examinations.
4. The "Table of Functions of the Ten-chord Spiral" submitted herewith, as supplementing and completing the table on pages 102-110 of the Manual and superseding the Table on page 111.
5. The headings "W = Length Theoretical Point to Toe" and "K = Length Theoretical Point to Heel" in place of "W = Length point to Toe" and "K = Length Point to Heel" in columns II and III, Table of Theoretical and Practical Switch Leads on page 92 of the Manual.

Your Committee recommends that subjects 2 and 3 be reassigned, the former with instructions as to the features to be studied.

Discussion.

Steel Tie-Plates.

C. A. Morse (C., R., I. & P. Ry.)—We use many ½-in. plates, and think that we should not require a minimum thickness of ⅝-in.

Earl Stimson (B. & O. R. R.)—I move (3) be stricken out.

J. B. Jenkins (B. & O. R. R.)—The Committee has changed the reading of paragraph (6) under workmanship and finish to read, "The spike holes must be punched clean cut, without burrs, and the plates must not be cracked or bent out of shape in punching the holes."

C. E. Lindsay (N. Y. C. & H. R. R.)—I think the paragraph on stamping of plates should read, "All plates must be stamped on the top side, outside the rail, with a mark indicating the section and weight of rail."

The Committee accepted the suggestion. Another suggestion was accepted to change the paragraph under "shipping" to read, "Tie plates must be wired together in bundles of uniform number, weighing not to exceed 100 lbs., and shall be properly tagged."

The specifications as amended, for steel tie plates, were submitted to vote and accepted.

Wrought Iron Tie-Plates.

L. C. Fritch (C., G. W. R. R.)—I move the adoption of these specifications with corrections similar to those for steel tie plates.

A motion to oil the plates before shipping was voted on and lost.

The specifications were voted on and accepted as amended.

Malleable Tie-Plates.

L. C. Fritch (C., G. W. R. R.)—Why are the widths and lengths of malleable plates required to vary not more than $\frac{1}{16}$ in., while in the other specifications the variation can be ⅛ in.?

J. B. Jenkins (B. & O. R. R.)—It is easier to regulate the cutting of malleable plates.

C. E. Lindsay (N. Y. C. & H. R. R.)—I move the article on "shipping" be changed to accord with the change on steel tie plates.

The Committee accepted the suggestion, and the specifications were voted on and accepted as amended.

Specifications for Track Bolts.

C. E. Lindsay (N. Y. C. & H. R. R.—I suggest the following clause under workmanship and finish: "Care must be taken to avoid overheating in manufacture."

The Committee accepted the suggestion, and the specifications were adopted as amended.

The specifiations for spring nut locks were adopted as read without discussion.

Specifications for Ordinary Track Spikes.

L. C. Fritch (C., G. W. R. R.)—I would suggest "per sq. in." be inserted in ultimate strength. I think it should be specified just how the spike should be measured.

J. B. Jenkins (B. & O. R. R.)—The Committee will have this paragraph read, "the length under the head, etc." These specifications will also be changed to agree with changes made in all the others.

The specifications were adopted as amended.

Specifications for Screw Spikes.

These specifications were adopted with a change under shipping to make the paragraph read, "Good serviceable packages."

Anti-Creepers.

C. E. Lindsay (N. Y. C. & H. R. R.)—I think paragraph (7) should read, "They must not loosen when in place sufficiently to render the anti-creeper inoperative when the rail slacks back."

The Committee accepted the suggestion, and the specifications were adopted as amended.

Track Labor.

E. F. Wendt (P. & L. E. R. R.)—The question of track labor, referred to in this report, is a very important one. Mr. Loree showed last year that 55% of railway expenses were chargeable to labor. The beginning of these studies relating to economics marks an epoch in the history of this association.

The cost of labor has advanced rapidly, and in greatly increased percentage to gross revenue. Three interests are entitled to a hearing on this question—the capitalist, the wage earner, and the patrons of the road.

Wages have risen 11.1% since 1890, and a decreasing portion of gross revenue has been returned to stockholders in order to pay an increasing amount to wage earners.

C. E. Lindsay (N. Y. C. & H. R. R.): I think this committee should take up the study of crossovers. We are told the recommendations of this committee are all wrong, and No. 20 crossovers are necessary for safety. The curvature at the switch point is important. I figure that with an engine with 17 ft. wheel base on a 15 ft. switch point with 6 in. spread at heel, the curvature is equivalent to 22° 35′; with 20 ft. point 16° 5′; and with a 30 ft. point 13° 6′. How fast is it safe to run over a switch point without any elevation?

J. B. Jenkins (B. & O. R. R.): The committee will submit a

W. C. Cushing, Chairman Committee on Rail.

design for cross-overs next year. Progress has been made in studying the relation of speed to turn-out radius, and the relation of speed to the switch angle.

RAIL.

W. C. Cushing, Chairman; R. Monfort, Vice-Chairman; E. B. Ashby, J. A. Atwood, A. S. Baldwin, J. B. Berry, M. L. Byers, Chas. S. Churchill, F. A. Delano, P. H. Dudley, C. H. Ewing, L. C. Fritch, C. W. Huntington, J. D. Isaacs, Thos. H. Johnson, H. G. Kelley, C. A. Morse, Geo. W. Kittredge, Jos. T. Richards, J. P. Snow, A. W. Thompson, R. Trimble, M. H. Wickhorst.

The work outlined by the Board of Direction for the year was as follows:

(a) Consider revision of the Manual; if no changes are recommended, make statement accordingly.

(b) Present recommendations on standard rail sections.

(c) Continue investigation of rail failures and present conclusions drawn therefrom.

(d) Continue special investigation of rails.

(e) Make concise recommendations for next year's work.

(A) REVISION OF MANUAL.

(a) Revision of Specifications for Carbon Steel Rails: The work of the Committee resulted, after several years, in the presentation, at the annual convention in 1912, of a set of specifications for carbon steel rails, which was adopted by the Association.

Since that time, some criticisms of the clearness of the meaning of one or two of the sections have been received, and the Committee has made a careful study of all the sections in the specifications, with a view to keeping them up to date and making them as perfect as possible, with the result that a few revisions are now submitted for adoption by the Association, some of them being merely changes in wording and rearrangement, which it is hardly necessary to point out in detail. The principal changes are, however, laid before you for approval, as follows:

Section 4. Chemical Composition: The words "of each heat" have been added, so that the section reads, "The chemical composition of each heat of the steel from which rails are rolled, determined as prescribed in Section 7, shall be within the following limits."

This change was made because the question arose at one mill as to whether it was necessary for every heat to have its chemical elements within the limits prescribed by the specifications.

Section 14. Elongation or Ductility: A new paragraph (b) has been added, as follows: "A sufficient number of blows shall be given to determine the complete elongation of the test piece of at least every fifth heat of Bessemer steel, and of one out of every three test pieces of a heat of Open-Hearth steel."

In measuring the elongation, acceptance or rejection is determined by the amount shown under one or more blows of the tup, but in addition to this, it is advisable to determine the total elongation or ductility of a certain number of test pieces, in order to keep informed on the toughness of the material, by repeating the blows till failure results. It is at present customary to carry on these tests, and it was thought advisable and proper to add the requirement to the specifications in order to make them more complete.

Section 17. Bessemer Process Drop Tests, Clause (b): The words "does not break and" have been added to the second line, so that the clause reads, "If the test piece breaks at the first blow or does not show the required elongation (Section 14), or if the test piece does not break and shows the required elongation, but when broken shows interior defect, all of the top rails from that heat shall be rejected." The words "nicked and" have also been omitted from both Clauses (a) and (b) and both the additions and ommissions were brought about by discussion as to the precise meaning of the clause. Some thought that when a test piece showed interior defect the rails it represented should not be rejected unless the test piece had been *nicked* and broken. This was not the real meaning of the clause, as nicking is only a matter of convenience and expedition in making the tests, but in order to avoid controversy, the changes have been made.

Similar changes have been made in (c), (d), (e) and (f).

Section 18. Open-Hearth Process Drop Tests: Clauses (a) and (b) have been made to read as follows, by the addition of some words and the omission of others:

(a) "If two of these test pieces do not break at the first blow, and if both show the required elongation (Section 14), all of the rails of the heat shall be accepted, provided that none of the three test pieces when broken show interior defect."

(b) "If two of the test pieces break at the first blow, or do not show the required elongation (Section 14), or if any of the three test pieces when broken show interior defect, all of the top rails from that heat shall be rejected."

Before change, these two clauses read as follows:

(a) "If two of these test pieces do not break at the first blow and show the required elongation (section 14), all of the rails of the heat shall be accepted, provided that these test pieces when nicked and broken do not show interior defect."

(b) "If two of the test pieces break at the first blow, or do not show the required elongation, or if any of the pieces that have been tested under the drop when nicked and broken show interior defect, all of the top rails from that heat shall be rejected."

In Clause (a), the changes were the addition of the words "if both," the addition of the words "none of the three," and the omission of the words "nicked and," also "do not."

In Clause (b), the additions were the words "three tests" and the omission of the words "that have been tested under the drop" and "nicked and."

The changes were made necessary to abolish any cause for dispute as to the meaning, because, as already explained for Section 17 (a) and (b), some were inclined to lay too much stress on the words "nicked and" when considering the rejection of certain rails represented by the test piece which showed interior defect, although it had not been nicked. The nicking was entirely a matter of convenience and if a test piece showed interior defect, it did not make any difference how it was broken. Similiar changes have been made in Clauses (c), (d), (e) and (f), for the same reasons.

Section 30. Straightening: A new clause (b) has been added as follows: "Rails heard to snap or check while being straightened shall be at once rejected."

It is well-known that the present method of straightening rails is undesirable, but it is the one almost universally employed and no other method now known is considered practicable. Sometimes, during this straightening process, rails are heard to snap, indicating that some unusual injury has been done, and it is the object of this clause to make that grounds for rejection.

The attention of the Committee has been called by Dr. Dudley to the automatic rail straighteners in use at the Lorain Steel Works, which may prove to be of advantage over those now in use, and their merits will be investigated.

Section 32. Finishing: A new clause (c) has been added, as follows: "When any finished rail shows interior defects at either end or in a drilled hole, the entire rail shall be rejected."

The rejection of such rails at the mills has been a source of dispute for several years, and in order to remove the cause for further contention, this clause has been added. Rejection of such rails is con-

sidered justifiable, as in the case of the rejection of the "A," "B" or "C" rails represented by the test piece which shows interior defect.

(b) Revision of Rail Record Forms (Manual Edition 1911, page 57):

"Report of Mill Inspection, Form M. W. 401." On page 59 of the manual is shown the present standard form of the Association, entitled "Report of Chemical and Physical Examination," but since the change in the rail specifications, it is no longer suitable for the purpose, because, in the case of Open-Hearth heats, three ingots of each heat are tested instead of one, and an elongation of ductility requirement has been added: consequently, it is necessary to have a form on which the additional results can be reported. The name has been changed to "Report of Mill Inspection," because of the similarity of the form name to that of M. W. 407, "Laboratory Report of Chemical and Physical Examination." A new form, to take the place of the old one, is therefore submitted for your approval.

"Certificate of Inspection, Form M. W. 402." In connection with the new specifications adopted by the Association, it has become advisable to make changes in the above form, now printed on page 60 of the Manual, and therefore a revised form is submitted to you for your approval. The principal change is the tabulation in two columns of the "Rails Accepted" and the different causes for "Rails Rejected."

"Laboratory Report of Chemical and Physical Examination of Rail, Form M. W. 407." The present standard form is illustrated on page 67 of the Manual, but, owing to progress in testing, which has resulted in the addition of tests, it has been found advisable to provide for the report of those additional tests; consequently, this form has been entirely revised, and a new blank is presented to you for approval.

"Tabulation of Results of Mill Inspection of Rails, Form M. W. 418." Owing to the change in the rail specifications, it will be necessary to revise this form, which is now illustrated between pages 60 and 61 of the Manual. A new form, with the necessary additions in columns for entering the observed data, is submitted to you for your approval.

(B) STANDARD RAIL SECTIONS.

The American Railway Association delegated to the Rail committee of the American Railway Engineering Association the question of sections of rail and other matters connected with them, as well as that of specifications.

For some time the subjects of specifications and rail sections have been considered by Sub-Committee "B," Mr. Berry, chairman, but about a year ago the subject of specifications was delegated to Sub-Committee "A" (in charge of the experimental investigations), while Sub-Committee "B" continued its work in connection with the study of rail sections.

The sections used by the various railroads were collected, comparison between them and sections suggested by members of the committee was made, and all of the information as to rail failures in connection with the sections which could be obtained was considered. Some of the members of the committee submitted sections for consideration where their studies suggested that changes might be made for a better section, the desire being to keep the section within certain lines so that rail joints could be used and have a bearing on the straight portion of the rail both under the head and on top of the base, with as little additional stress on the bolts as possible.

The sub-committee is not in a position to recommend any new section at the preesnt time, for the reason that the sections of the so-called A.R.A. types "A" and "B" had been used by a number of roads, and they are getting good results as compared with other sections, but they had only been in use for about three years at the most, and with a great many roads only about two years. It is the consensus of opinion of the sub-committee that it may be advisable (but, perhaps, not so much as suggested by the sections under consideration) to add a little to the fillets both under the head and at the base.

The proposal of the sub-committee was to continue still to use types "A" and "B" while making further studies in regard to them, and make no recommendation for additional section or sections at the present time.

The sub-committee, however, has under consideration modified sections, and will continue the study from time to time as it obtains information concerning the weak spots in the present sections.

It will also undertake to make a study of rail joints and report at future meetings.

In regard to rail stresses: There is a great deal of indefiniteness about how various parties have estimated them. Mr. P. M. La Bach, of the Rock Island Lines, has worked on this problem, and the results have been sent out in sections to the members of the Rail Committee. He is now revising the information, and putting it in better shape. The committee will also have other data that it will use in connection with the above, and it may be necessary for some members of the Association to make experiments of their own in regard to the matter so that the committee will have the best information available of what the approximate stresses in rail under normal conditions are.

This is intended to lead up to experiments on the track for the purpose of studying the stresses from measurement under service conditions, if it is found practicable to do so.

The subject of "Stresses to Which Rails are Subjected in Service" has been under preliminary investigation for the past year by Sub-Committee "D," Mr. Baldwin, chairman. As preliminary information, a short brochure by Dr. P. H. Dudley is submitted as Appendix "M." In this, he describes a few stremmatograph tests of track under service conditions. This is followed by a bibliography of information on the general subject.

(C) STATISTICS OF RAIL FAILURES.

The statistics of rail failures for the year ending Oct. 31, 1911, were prepared by Mr. Trimble, and are given as Appendix "G," having been issued first in Bulletin No. 147, for July, 1912.

The responses have been more complete than ever before, and the information furnished relates to 12,893,007 tons of rail. A careful perusal is recommended, as the report contains a great deal of valuable and useful information; nevertheless, it is proper to call the attention of the members to the fact that it is impossible to make comparisons under similar conditions of traffic, roadbed and weight of rail when dealing with the reports from companies whose problems vary widely, and because it is not feasible to obtain the information which would be necessary to make comparisons accurate, such, for instance, as the tonnage which has passed over rail of equal age and with the same quality of roadbed. The record of comparative wear of special rail, however, is being kept in such a way that comparisons are possible. The deductions from the report will be found on page 372.

(D) SPECIAL INVESTIGATION OF RAILS.

Experiments and Tests.

Mr. M. H. Wickhorst, Engineer of Tests for the committee, has continued his work on experiments and tests under the direction of Sub-Committee "A," Mr. Atwood, chairman, for the past year, and the results of his work are issued in appendices named later. The cost of this work to the railways has been borne entirely by the American Railway Association, and the total appropriations made since November, 1909, up to November, 1912, have been $21,000, while the expenditures to the end of the same period were $21,011.41. These appropriations were divided for each year as follows:

November, 1909	$ 5,000
November, 1910	6,000
October, 1911	10,000
Total	$21,000

In addition to the above, some of the manufacturers have incurred large expenses, the amount of which is not known, through the use of their facilities and material when the investigations were made.

During the year 1912 the Engineer of Tests made reports to the Rail Committee as follows:

No. 22, March, 1912, Abrasion Tests of Rails on Revolving Machine (Bulletin No. 147).

No. 24, April, 1912, Influence of Titanium on Bessemer Ingots and Rails (Bulletin No. 147).

No. 25, May, 1912, Pipeless Ingots (Bulletin No. 147).

No. 26, June, 1912, Transverse Ductility of Base of Rails (Bulletin No. 147).

No. 33, October, 1912, Influence of Silicon on Open-Hearth Ingots and Rails, Appendix L (Bulletin No. 151).

Each report contains a summary of the matter contained in it, but below is given a digest of the main results obtained:

Report 22 gave the results of abrasion tests of rails made at several different mills. The tests were made at the South Chicago works of the Illinois Steel Company on a "revolving machine," consisting of a circular track 20 feet in diameter, on which a heavy beam revolved which could be given additional load by means of springs. Under the conditions of this test open-hearth steel of .74 per cent carbon abraded more slowly than Bessemer steel of .50 to .54 per cent carbon, but the tests were not entirely satisfactory and were few in number.

Report 24 gave the results of an investigation made at the works of the Lackawanna Steel Company at Buffalo, to determine the influence of titanium on Bessemer steel ingots and rails. A series of heats was made with treatments varying from nothing to .6 per cent metallic titanium added in the form of a cold 15 per cent alloy. According to the results obtained, the use of amounts of .1 per cent or more of metallic titanium in the manner mentioned, prevents the "honeycombed" condition of the upper part of the ingot found in plain Bessemer steel, but is also attended with a larger and deeper "pipe." The heavy segregation or concentration of carbon, phosphorus and sulphur found in the interior and upper part of ingots of plain Bessemer steel is largely restrained, but the mild negative segregation found in the interior and lower part of the ingot is not materially altered. The brittle zone found in rail of plain Bessemer steel from the upper part of the ingot, as determined by drop and tensile tests, was avoided, but the properties of the rail from the lower two-thirds of the ingot were not changed. Large internal flaws were found in rail considerably lower down from the top of the ingot in steel treated as mentioned, than in rail made from plain steel. Treatments with .05 per cent metallic titanium produced the above results only in part, but treatment above .1 per cent had only little additional influence.

Report 25 dealt with an investigation of two special ingots made by the Standard Steel Works Company at Burnham, Pa., by a process which prevents the formation of a "pipe" in the interior of the ingot.

The steel was acid Open-Hearth steel treated with titanium. The ingots were shipped to the Maryland Steel Company at Sparrows Point, Md., where they were tested. The main feature of the casting process was a sand core on top of the iron mold. The ingots were cupped down at the top but contained no interior pipe.

Report 26 gave a description of a method for determining the transverse ductility of the bottom of the base of a rail and the load required to break the flanges of a rail supported near the edges of the flanges. The results were given of a few tests made at Buffalo at the works of the Lackawanna Steel Company, of Bessemer and Open-Hearth rails. The method of making the tests was to support a piece of rail about 2 feet long on two supports placed opposite each other near the edges of the flanges under the middle of the length of the rail. The supports were six inches long and placed one-half inch in from the sides of the flanges. The load was applied in the test machine to the top of the rail at the middle. The method may be considered a means of determining the strength of the flange and of determining the transverse properties of the base of the rail, as regards the transverse ductility of the metal in the base and the presence of structural flaws such as seams.

Report 33 gave the results of an investigation made at the Gary works of the Illinois Steel Company on the influence of silicon on Open-Hearth ingots and rails. A heat was used of about .15 per cent silicon and a series of higher silicons was obtained in this steel up to above .5 per cent by means of mold additions of finely crushed ferro-silicon. With about one-fourth per cent silicon or more the ingots were free from most of the honeycomb present in the upper third of the ingot with the heat amount of silicon, but they also had larger pipes. The higher silicons also had less concentrated segregation of carbon, phosphorus and sulphur. Silicon had but little influence on the results in the drop test. When tested in the test machine as a beam, the stiffness and breaking load of the rails increased with increase of silicon, while their ductility was not greatly influenced. In longitudinal tensile tests, the yield point and tensile strength increased somewhat with increase of silicon while the ductility remained about the same. In tests of the flange, the load required to break the flange increased somewhat as the silicon increased, while the transverse ductility of the base remained about the same.

The above work concerning both titanium and silicon indicate that they tend to restrain segregation of carbon, phosphorus and sulphur, but used as they were in this work they were attended with larger pipes. This suggests the idea that in order to obtain the full benefits of their use, a method of casting the ingots is necessary whereby the pipe is avoided or minimized.

MISCELLANEOUS.

Testing Each Ingot: The question of testing each ingot has been quite thoroughly considered by correspondence and by discussion, and the committee recommends that no change be made in the specifications in this respect at present, for the following reasons:

(a) The tests now required by the specifications are sufficient to determine the character of the metal in the heat. In so far as it is intended to discover specific flaws in the rail, additional tests would have relatively little value, as these defects are quite local, and are apt to occur in any part of the ingot, or rail bar; so that the presence or absence of internal defects in the piece tested is no certain criterion of the presence or absence of similar defects in other parts of the same bar.

(b) The character of the metal in the rails of one heat varies *down* the ingot more than it does from one ingot to another, and in making the complete drop test of an open-hearth heat, the three tests made from approximately the poorest parts of the ingots designate the average of the poorest part of the metal fully as well as if we tested a piece from each ingot.

(c) Careful examination in detail of the many tests of open-hearth rail made in the last two years on the New York Central Lines fails to show any necessity for the testing of each individual ingot.

Ductility and Elongation Tests, Appendix "A" (Bulletin No. 147.): Dr. Dudley has written a description, in Appendix "A," of the ductility and elongation tests as conducted on the New York Central Lines, which was intended to be a part of last year's report, in Bulletin No. 143. Such information is interesting and instructive, as we like to keep informed of how our fellow-members handle the daily problems which come before them.

Influence of Seams or Limitations in Base of Rail on Rail Failures, Appendix "F" (Bulletin No. 147.): Mr. H. B. McFarland, engineer of tests of the Santa Fe System, has furnished the committee with an important study of base failures, which supplements the work of like character presented by Mr. Wickhorst in Appendix "E," entitled "Transverse Ductility of Base of Rails." This type of failure has been dwelt upon at great length by Mr. James E. Howard, engineer-physicist of the Bureau of Standards, in the report of accident on the Great Northern Ry., near Sharon, N. D., December 30, 1911. The committee is making a special study of this character of failure, in order to devise a practicable test which will result in its discovery before the rails leave the mill.

Effect of Piping, Cavities and Porous Spots in Ingots on the Finished Rail, Appendix "H" (Bulletin No. 147.): Our knowledge on this subject has been improved through the study by Mr. Onderdonk, engineer of tests of the Baltimore & Ohio Railroad System. The study is a very important one, as it is impossible to have sound rails from unsound ingots.

Investigation of Silvery Oval Spots, Sometimes Called "Transverse or Internal Fissures," in the Rail Heads, Appendix "I": The contribution by Mr. C. D. Young, engineer of tests, and by Mr. F. N. Pease, chemist, of the Pennsylvania Railroad, on this subject is a valuable addition to our knowledge, as there has been quite a dispute over the cause of this type of defect, which was but recently brought to our attention. It is quite possible that such defects have heretofore caused rail failures, but if such be true, it has not been a matter of general knowledge.

Method of Producing Sound Ingots, Appendix "J": This is another appendix relating to sound ingots, which we have been extremely fortunate in securing for the information of our members, as the articles are by a Past-President of the Iron and Steel Institute of Great Britain, Sir Robert A. Hadfield, a manufacturer of steel, and a profound student of the problems arising in its manufacture. This information is an important addition to that of Mr. Wickhorst's report on "Pipeless Ingots," in Appendix "D," as there is some difference in the practice described in the two papers, which Sir Robert has himself explained in a note in the introduction to his reports.

The Testing of Rails, Appendix "L": This is a foreign paper, taken from the Bulletin of the International Railway Congress, which contains information in line with Mr. Wickhorst's "Abrasion Tests on Revolving Machine," issued as Appendix "B."

(E) RECOMMENDATIONS FOR WORK IN 1913.

The subjects recommended for assignment to the committee for 1913 are the same as those already assigned for the year 1912, and in addition the subject of rail joints.

The general line of investigation which the committee has in view for Mr. Wickhorst is submitted below, and embraces a great deal more work than he can cover in any one year, but it is well to keep before us the subjects which are important and will demand our attention.

The main point kept in mind in the work of the last two or three years has been to conduct it so as to bring out if possible information useful in improving rails for the purpose of making them uniformly safe, and it is probable that this must continue to be our guiding principle for some time to come. Investigations intended to improve the wearing properties of rails must, it would seem, be considered as secondary to those which have uniform safety as the prime consideration. It soon developed that the type of rail failure which was uppermost in our attention a few years ago, namely, split and mashed heads, was traceable to the interior condition of the ingot and our work has consisted therefore largely of "ingot" studies. Recently, failures classified as broken rails and broken base, have been brought more to our attention, due largely to last winter's crop of broken rails. It seems that such failures are largely attended or perhaps caused by deep seams in the base of the rail and it is now proposed that the work of the immediate future be directed toward throwing light on the cause of such seams and methods for their prevention.

Among the subjects needing investigation the following may be listed:

Making Ingots:

(1) Influence of height of ingot on segregation and interior cavities, Bessemer and Open-Hearth steel.

(2) Influence of diameter of ingot, Open-Hearth steel.

(3) Influence of the rate of pouring the ingot.

(4) Influence of temperature of liquid steel when poured into molds.

(5) Influence of thickness of mold.

Making Rails:

(6) Influence of temperature of rolling on high carbon Open-Hearth rails.

(7) Causes of seams in base of rails.

(8) Influence of rate of reduction in rolling.

(9) Influence of methods of cooling on cooling beds.

(10) Effect of cold straightening rails.

(11) Influence of length of time in soaking pit on grain size.

Composition:

(12) Influence of titanium on Open-Hearth ingots and rails.

(13) Quantitative influence of carbon on deflection and ductility.

(14) Quantitative influence of phosphorus on deflection and ductility.

(15) Quantitative influence of manganese on deflection and ductility.

Miscellaneous:

(16) Investigate electric steel rails.

(17) Investigate acid Open-Hearth steel rails.

(18) Influence of low temperatures on ductility and other properties of rails.

(19) Influence of heat treatment on the properties of rail steel.

Conclusions.

The committee makes the following recommendations for your approval:

(1) That the revision of the specifications for carbon steel rails, presented herewith, be approved for printing in the Manual.

The revisions, together with the explanations, are given in detail in the first part of the report, under "A—Manual, Section (a)."

(2) That Form M. W. 401, "Report of Mill Inspection," as revised and presented herewith, be approved for substitution in the Manual for the present standard form.

The explanation of the proposed revisions is given under "A—Manual, Section (b)."

(3) That Form M. W. 402, "Certificate of Inspection," as revised and presented herewith, be approved for substitution in the Manual for the present standard form.

The explanation of the proposed revisions is given under "A—Manual, Section (b)."

(4) That Form M. W. 407, "Laboratory Rail Report," as presented herewith, be approved for substitution in the Manual for the present standard form.

The explanation of the proposed revisions is given under "A—Manual, Section (b)."

(5) That Form M. W. 418, "Tabulation of Results of Mill Inspection of Rails," as revised and presented herewith, be approved for substitution in the Manual for the present standard form.

The explanation of the proposed revisions is given under "A—Manual, Section (b)."

SPECIFICATIONS FOR CARBON STEEL RAILS.
1913.

Inspection.

Access to Works. 1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the rails have been made in accordance with the terms of the specifications.

Place for Tests. 2. All tests and inspections shall be made at the place of manufacture, prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the mill.

Material.

Material. 3. The material shall be steel made by the Bessemer or Open-Hearth process as provided by the contract.

Chemical Requirements.

Chemical Composition. 4. The chemical composition of each heat of the steel from which the rails are rolled, determined as prescribed in Section 7, shall be within the following limits:

Elements	Per Cent. for Bessemer Process		Per Cent. for Open-Hearth Process	
	70 lbs. and over, but under 85 lbs.	85 - 100 lbs. inclusive	70 lbs. and over, but under 85 lbs.	85 - 100 lbs. inclusive
Carbon	0.40 to 0.50	0.45 to 0.55	0.53 to 0.66	0.63 to 0.75
Phosphorus, not to exceed	0.10	0.10	0.04	0.04
Manganese	0.80 to 1.10	0.80 to 1.10	0.60 to 0.90	0.60 to 0.90
Silicon, not to exceed	0.20	0.20	0.20	0.20

Chemical Requirements, Steel Rails.

Average Carbon. 5. It is desired that the percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits specified.

Modification of Carbon for Low Phosphorus. 6. When the material used at any mill is such that the average phosphorus content of the ingot metal used in the Bessemer process is running below 0.08 and in the Open-Hearth process is running below 0.03, and if it seems mutually desirable, the carbon may be increased at the rate of 0.035 for each 0.01 that the phosphorus content of the ingot metal used averages below 0.08 for Bessemer steel, or 0.03 for Open-Hearth steel.

Analyses. 7. In order to ascertain whether the chemical composition is in accordance with the requirements, analyses shall be furnished as follows:

(a) For Bessemer process the manufacturer shall furnish to the inspector, daily, carbon determinations for each heat before the rails are shipped, and two chemical analyses every twenty-four hours representing the average of the elements, carbon, manganese, silicon, phosphorus and sulphur contained in the steel, one for each day and night turn respectively. These analyses shall be made on drillings taken from the ladle test ingot not less than one-eighth inch beneath the surface.

(b) For Open-Hearth process, the makers shall furnish the inspectors with a chemical analysis of the elements, carbon, manganese, silicon, phosphorus and sulphur, for each heat.

(c) On request of the inspector, the manufacturer shall furnish a portion of the test ingot for check analyses.

Physical Requirements.

Physical Qualities. 8. Tests shall be made to determine.

(a) Ductility or toughness as opposed to brittleness.

(b) Soundness.

Method of Testing. 9. The physical qualities shall be determined by the Drop Test.

Drop Testing Machine. 10. The drop testing machine used shall be the standard of the American Railway Engineering Association.

(a) The tup shall weigh 2,000 lbs., and have a striking face with a radius of five inches.

(b) The anvil block shall weigh 20,000 lbs., and be supported on springs.

(c) The supports for the test pieces shall be spaced three feet between centers and shall be a part of, and firmly secured, to the anvil. The bearing surfaces of the supports shall have a radius of five inches.

Pieces for Drop Test. 11. Drop tests shall be made on pieces of rail not less than four feet and not more than six feet long. These test pieces shall be cut from the top end of the top rail of the ingot, and marked on the base or head with gage marks one inch apart for three inches each side of the center of the test piece, for measuring the ductility of the metal.

Temperature of Test Pieces. 12. The temperature of the test pieces shall be between 60 and 100 degrees Fahrenheit.

Height of Drop. 13. The test piece shall, at the option of the inspector, be placed head or base upwards on the supports, and be subjected to impact of the tup falling free from the following heights:

For 70-lb. rail.....16 feet
For 80, 85 and 90-lb. rail.....17 feet
For 100-lb. rail.....18 feet

Elongation or Ductility. 14. (a) Under these impacts the rail under one or more blows shall show at least 6 per cent elongation for one inch, or 5 per cent each for two consecutive inches of the six-inch scale, marked as described in Section 11.

(b) A sufficient number of blows shall be given to determine the complete elongation of the test piece of at least every fifth heat of Bessemer steel, and of one out of every three test pieces of a heat of Open-Hearth steel.

Permanent Set. 15. It is desired that the permanent set after one blow under the drop test shall not exceed that in the following table, and a record shall be made of this information.

Test to Destruction. 16. The test pieces which do not break under the first or subsequent blows shall be nicked and broken, to determine whether the interior metal is sound.

Rail			Permanent Set, measured by Middle Ordinate in Inches in a Length of 3 Feet	
Section	Weight per Yard	Moment of Inertia	Bessemer Process	O.-H. Process
A.R.A.-A	100	48.94	1.65	1.45
A.R.A.-B	100	41.30	2.05	1.80
A.R.A.-A	90	38.70	1.90	1.65
A.R.A.-B	90	32.30	2.20	2.00
A.R.A.-A	80	29.80	2.85	2.45
A.R.A.-B	80	25.00	3.15	2.85
A.R.A.-A	70	21.05	3.50	3.10
A.R.A.-B	70	18.60	3.85	3.50

Allowable Permanent Set, Bending Test.

Bessemer Process Drop Tests. 17. One piece shall be tested from each heat of Bessemer steel.

(a) If the test piece does not break at the first blow and shows the required elongation (Section 14), all of the rails of the heat shall be accepted, provided that the test piece when broken does not show interior defect.

(b) If the test piece breaks at the first blow, or does not show the required elongation (Section 14), or if the test piece does not break and shows the required elongation, but when broken shows interior defect, all of the top rails from that heat shall be rejected.

(c) A second test shall then be made of a test piece selected by the inspector from the top end of any second rail of the same heat, preferably of the same ingot. If the test piece does not break at the first blow, and shows the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the test piece when broken does not show interior defect.

(d) If the test piece breaks at the first blow, or does not show the required elongation (Section 14), or if the test piece does not break and shows the required elongation, but when broken shows interior defect, all of the second rails from that heat shall be rejected.

(e) A third test shall then be made of a test piece selected by the inspector from the top end of any third rail of the same heat, preferably of the same ingot. If the test piece does not break at the first blow and shows the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the test piece when broken does not show interior defect.

(f) If the test breaks at the first blow, or does not show the required elongation (Section 14), or if the test piece does not break and shows the required elongation, but when broken shows interior defect, all of the remainder of the rails from that heat shall be rejected.

Open-Hearth Process Drop Tests. 18. Test pieces shall be selected from the second, middle and last full ingot of each Open-Hearth heat.

(a) If two of these test pieces do not break at the first blow, and if both show the required elongation (Section 14), all of the rails of the heat shall be accepted, provided that none of the three test pieces when broken show interior defect.

(b) If two of the test pieces break at the first blow, or do not show the required elongation (Section 14), or if any of the three test pieces when broken show interior defect, all of the top rails from that heat shall be rejected.

(c) Second tests shall then be made from three test pieces selected by the inspector from the top end of any second rails of the same heat, preferably of the same ingots. If two of these test pieces do not break at the first blow and if both show the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that none of the three test pieces when broken show interior defect.

(d) If two of these test pieces break at the first blow, or do not show the required elongation (Section 14), or if any of the three test pieces when broken show interior defect, all of the second rails of the heat shall be rejected.

(e) Third tests shall then be made from three test pieces selected by the inspector from the top end of any third rails of the same heat, preferably of the same ingots. If two of these test pieces do not break at the first blow, and if both show the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that none of the three test pieces when broken show interior defect.

(f) If two of these test pieces break at the first blow, or do not show the required elongation (Section 14), or if any of the three test pieces when broken show interior defect, all of the remainder of the rails from that heat shall be rejected.

No. 1 Rails. 19. No. 1 classification rails shall be free from injurious defects and flaws of all kinds.

No. 2 Rails. 20. (a) Rails, which, by reason of surface imperfections, or for causes mentioned in Section 30 hereof, are not classed as No. 1 rails, will be accepted as No. 2 rails, but No. 2 rails which contain imperfections in such number or of such character as will, in the judgment of the inspector, render them unfit for recognized No. 2 uses, will not be accepted for shipment.

(b) No. 2 rails to the extent of 5 per cent of the whole order will be received. All rails accepted as No. 2 rails shall have the ends painted white and shall have two prick punch marks on the side of the web near the heat number near the end of the rail, so placed as not to be covered by the splice bars.

DETAILS OF MANUFACTURE.

Quality of Manufacture. 21. The entire process of manufacture shall be in accordance with the best current state of the art.

Bled Ingots. 22. Bled ingots shall not be used.

Discard. 23. There shall be sheared from the end of the bloom, formed from the top of the ingot, sufficient metal to secure sound rails.

Lengths. 24. The standard length of rails shall be 33 feet, at a temperature of 60 degrees Fahrenheit. Ten per cent of the entire order will be accepted in shorter lengths varying by 1 foot from 32 feet to 25 feet. A variation of one-fourth inch from the specified lengths will be allowed. No. 1 rails less than 33 feet long shall be painted green on both ends.

Shrinkage. 25. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass, the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a rail 33 feet in length and of 100 lbs. section, of six and three-fourths inches and one-eighth inch less for each ten lbs. decrease in section.

Cooling. 26. The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling them be used after they leave the finishing pass. Rails, while on the cooling beds, shall be protected from snow and water.

Section. 27. The section of rails shall conform as accurately as possible to the template furnished by the Railroad Company. A variation in height of one-sixty-fourth inch less or one-thirty-second inch greater than the specified height, and one-sixteenth inch in width of flange, will be permitted; but no variaton shall be allowed in the dimensions affecting the fit of the splice bars.

Weight. 28. The weight of the rails specified in the order shall be maintained as nearly as possible, after complying with the preceding Section. A variation of one-half of 1 per cent from the calculated weight of section, as applied to an entire order, will be allowed.

Payment. 29. Rails accepted will be paid for according to actual weights.

Straightening. 30. (a) The hot straightening shall be carefully done, so that gagging under the cold presses will be reduced to a minimum. Any rail coming to the straightening presses showing sharp kinks or greater camber than that indicated by a middle ordinate of 4 inches in 33 feet, for A. R. A. type of sections, or 5 inches for A. S. C. E. type of sections, will be at once classed as a No. 2 rail. The distance between the supports of rails in the straightening presses shall not be less than 42 inches. The supports shall have flat surfaces and be out of wind.

(b) Rails heard to snap or check while being straightened shall be at once rejected.

Drilling. 31. Circular holes for joint bolts shall be drilled to conform accurately in every respect to the drawing and dimensions furnished by the Railroad Company.

Finishing. 32. (a) All rails shall be smooth on the heads, straight in line and surface, and without any twists, waves or kinks. They shall be sawed square at the ends, a variation of not more than one-thirty-second inch being allowed; and burrs shall be carefully removed.

(b) Rails improperly drilled or straightened, or from which the burrs have not been removed, shall be rejected, but may be accepted after being properly finished.

(c) When any finished rail shows interior defects at either end or in a drilled hole the entire rail shall be rejected.

Branding. 33. (a) The name of the manufacturer, the weight and type of rail, and the month and year of manufacture shall be rolled in raised letters and figures on the side of the web. The number of the heat and a letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail, where it will not be covered by the splice bars. The top rails shall be lettered "A," and the succeeding ones "B," "C," "D," etc., consecutively; but in case of a top discard of twenty or more per cent, the letter "A" will be omitted. All marking of rails shall be done so effectively that the marks may be read as long as the rails are in service.

(b) Open-Hearth rails shall be branded or stamped "O.-H.," in addition to the other marks.

Separate Classes. 34. All classes of rails shall be kept separate from each other.

Loading. 35. All rails shall be loaded in the presence of the inspector.

Discussion.

W. C. Cushing, Penn. Lines West, read a letter written by John Edgar Thompson in 1864, relating to the iron rail problem and necessity for improvement. He made the point that the committee's work was not done, and judging from the past the rail question will always be a live one, although great progress is being made.

W. L. Seddon (S. A. L. R. R.): Have the manufacturers been making progress, and are rail mills rolling rails according to our specifications?

W. C. Cushing (Penn. L. W.): Distinct progress is being made, although no rails are being rolled exactly to our specifications. Conferences have been held by railway presidents and rail mill owners to bring about this result.

H. M. Wickhorst: Ninety per cent of rail failures can be divided into two general classes: 50% are due to poor metal, so 50% of our problem is getting good metal. The other 40% of the problem is to eliminate seams in the base; i. e., to obtain more careful work in the rolling mill.

A vote of thanks was tendered the committee and the meeting adjourned till Wednesday.

ECONOMICS OF RAILWAY LOCATION.

A. K. Shurtleff, *Chairman;* R. N. Begien, *Vice-Chairman;* F. H. Alfred, A. C. Dennis, C. P. Howard, F. W. Green, P. M. LaBach, Fred Lavis, F. W. Smith, H. J. Simmons, Walter Loring Webb, M. A. Zook.

The B. & O. R. R. has made some extensive tests with a dynamometer car, and your Committee appreciates the paper presented by Mr. R. N. Begien, its Vice-Chairman, which is made an appendix to this report and recommends the adoption of conclusions therein, with reference to train and curve resistance, to take the place of Conclusions 2, 3, 4 and 7, as given in the 1911 Manual.

The Chairman of your Committee has made a study to determine the approximate general laws affecting such Maintenance of Way accounts as are influenced by changes in physical characteristics of locations and presents the results of this study for the consideration of the Association.

The conclusions presented are recommended for adoption, believing that the application of the formulas therein to the normal annual charge for each account will eliminate considerable of the guesswork of the past. The ratios of cost per mile of side track to mile of main track on any particular line can be estimated without too great an element of guesswork, and in the average case it will not be found far from the suggested value in the table. With these conclusions adopted your Committee has a way opened for the further study of questions entering into economics of location.

ANALYSIS OF MAINTENANCE OF WAY AND STRUCTURE ACCOUNTS.

The majority of the problems of Economics of Railway Location deal only with main track questions, although an occasional problem introduces the consideration of side tracks. It is therefore necessary to analyze and separate certain of the primary operating accounts between costs for main track and costs for sidings, particularly those accounts covering Maintenance of Way and Structures.

The following gives only the accounts which are particularly due to both main and sidetrack usage.

Account 1.—*Superintendence of Way and Structures.* One mile of

side track requires practically one-third the cost of one mile of main track.

Account 2.—*Ballast.* One mile of ballasted side track averages only about one-fourth the cost of one mile of ballasted main track. This factor is a difficult one to reach logically and is a matter of judgment. No detail figures have been obtainable, as usually only a minor portion of side tracks are ballasted and not all main tracks.

Account 3.—*Ties.* The number of renewals per mile of side track for four years averaged about 70 per cent of the number per mile of main track. The side track renewals embraced No. 2 ties as well as No. 1, and the average cost per side track tie was about 70 per cent of the cost per tie for main track, making the total charge for this account, due almost wholly to the costs of turnout frogs and switch points.

Account 6.—*Roadway and Track.* The cost per mile of side track averages about one-third the cost per mile of main track. This is due not only to the lower grades of maintenance of side track, but to the fact that many items charged into this account are principally main track items; for example, ditching, bank widening, track walkers, cutting weeds on right of way, etc.

Account 9.—*Bridges, Trestles and Culverts.*

Account 10.—*Over and Undergrade Crossings.* Occasionally a small portion of these two accounts is chargeable to side tracks, but for the majority of cases the amount is so small as to be negligible in economic calculations.

RAILROAD	Equivalent 1,000 Ton Miles per Mile Main Track			Costs per Mile Main Track						Renewals per Mile of Main Track		
	Freight	Passenger	Total	Acct. 1 Supt.	Acct. 6 R.W. & T.	Acct. 18 R.W.Tools Etc.	Acct 4 Rails	Acct. 5 Other Track Material	Acct. 16 Building	Tons Steel	Ties No.	Ties Average Cost
Pennsylvania R. R.	8,920	4,695	12,724	$142	$918	$ 28	$129	$131	$359	11.51	248	$1.00
D. L. & W.	7,338	4,532	11,870	111	619	33	301	152	294	20.22	209	.83
Pennsylvania Co.	7,629	4,106	11,735	109	774	12	107	101	265	3.86	228	1.13
P. & L. E.	8,269	2,771	11,040	136	1,282	40	171	161	348	24.86	384	1.17
N. Y. C. & St. L.	8,898	2,120	11,018	71	665	20	119	101	121	11.29	367	.78
P. & R.	7,888	3,627	11,515	100	681	26	130	117	279	12.22	287	.87
Vandalia	3,817	2,900	6,717	105	455	13	67	51	95	2.38	285	.65
L. S. & M. S.	6,060	4,412	10,472	77	824	48	90	105	260	5.78	289	1.12
N. Y. C. & H. R.	5,451	5,062	10,513	119	619	23	165	107	279	15.60	260	.85
C. R. R. of N. J.	6,263	3,996	10,259	71	714	14	128	120	457	16 24	242	.94
Northern Cen.	6,500	3,258	9,758	133	743	20	144	138	677	9.61	215	1.42
N. & W.	7,652	1,766	9,418	51	517	32	147	106	167	11.06	380	.57
P. C. C. & St. L.	5,979	3,368	9,347	100	704	9	97	85	161	3.39	205	1.20
Erie	5,766	3,269	9,045	82	569	19	105	80	167	18.02	223	.84
Lehigh Valley	6,405	2,280	8,685	76	469	17	109	70	196	7.54	153	.98
B. & O.	6,053	2,799	8,852	83	598	11	92	52	164	6.37	170	.93
P. B. & W.	3,478	5,558	9,036	141	678	26	56	93	293	5.73	310	.89
D. & H. Co.	6,151	2,311	8,462	46	377	15	77	77	134	5.00	176	.73
C. C. C. & St. L.	4,720	3,424	8,144	68	496	16	53	87	187	6.04	327	.87
C. & O.	5,688	1,770	7,458	50	504	18	69	73	123	6.11	317	.64
Wabash	4,155	2,642	6,797	34	445	8	71	56	100	3.44	397	.59
C. & A.	3,897	3,001	6,898	57	532	12	42	82	136	5.48	275	.67
Illinois Cen.	3,965	2,341	6,306	60	486	18	44	62	158	4.36	258	.64
Long Island	805	5,651	6,456	125	525	25	25	43	251	2.30	195	.92
D. M. & N.	4,749	790	5,539	46	1,149	28	69	66	176	5 89	204	.44
C. & E. I.	3,846	1,779	5,625	58	253	7	28	47	63	3.00	123	1.07
Mobile & Ohio.	4,077	1,392	5,469	41	364	12	38	54	88	4.36	476	.40
L. & N.	3,487	1,888	5,375	64	427	18	113	67	200	7.02	324	.68
S. P.; G. H. & S. A.	2,170	3,146	5,316	82	602	31	76	96	147	6.60	283	.57
A. T. & S. F.	2,603	2,536	5,139	90	564	28	55	56	160	7.01	302	.74
T. P.; O. S. L.; O.-W. R. R. & N. Co.	2,322	2,455	4,777	77	514	28	30	57	128	5.25	243	.78
N. C. & St. L.	2,739	1,931	4,670	52	607	14	42	47	115	2.74	519	.43
C. G. W.	2,526	1,898	4,424	84	342	7	17	43	78	16.59	441	.....
C. B. & Q.	2,351	1,943	4,294	62	454	8	69	26	126	15.01	337	.56
C. & N.-W.	2,269	2,074	4,343	41	407	8	46	35	112	4 58	227	.52
C. R. I. & P.	2,176	2,184	4,360	62	371	11	34	35	132	2.85	245	.79
Canadian Pac.	2,298	1,879	4,177	45	580	16	68	40	164	9.11	240	.40
M. K. & T.	2,072	2,063	4,135	47	434	16	11	45	83	3.00	420	.48
Southern.	2,176	2,033	4,209	55	299	9	73	47	83	5.89	374	.49
C. St. P. M. & O.	2,118	1,953	4,071	40	367	8	59	34	106	6.24	262	.50
C. M. & St. P.	2,400	1,618	4,018	28	311	15	53	34	89	7.24	197	.54
Northern Pacific	2,074	1,935	4,009	59	501	11	28	30	79	3.17	404	.45
Great Northern	1,968	1,933	3,901	64	561	11	28	41	66	3.14	320	.52
St. L. & S. F.	2,030	1,908	3,938	70	335	14	21	37	76	2.67	396	52
Pere Marquette	2,295	1,300	3,595	33	267	6	18	83	65	4.63	192	.66
Texas & Pacific	2,051	1,439	3,490	30	364	13	32	41	135	2.64	329	.50
Mo. P.; St. L. I. M. & S.	2,050	1,492	3,542	76	384	15	61	53	77	6.64	409	.53
D. & R. G.	1,845	1,685	3,530	73	493	21	21	31	69	1.80	283	.70
Y. & M. V.	1,932	1,125	3,057	65	468	28	35	66	118	3.19	430	.58
Seaboard Air Line	1,674	1,538	3,212	38	319	13	23	46	91	4.69	381	.35
Atlantic Coast Line	1,586	1,536	3,122	39	260	11	66	41	89	9.92	324	.41
M. St. P. & S. Ste. M.	1,788	1,293	3,081	17	246	7	2	16	53	1 75	234	.27
Cen. of Georgia	1,453	1,360	2,813	63	270	11	62	42	94	6.42	302	.43
Average cost per mile of side tracks in per cent of main track cost				33⅓%	33⅓%	33⅓%	25%	100%				

Division of Costs, Maintenance of Way and Structure Accounts.

per mile of side track practically one-half of the cost per mile of main track.

Account 4.—*Rails.* Main line rail was relaid by new rail, re-rolled rail or good relayers of heavier section, in all cases the renewal portion of the charges being only the tonnage equal to the weight of the released rail at the charge per ton for the material replacing it. Side track renewals were from relayers only and charged out on the above principle according to the form prescribed by the Interstate Commerce Commission. The arbitrary credit for relayers released and charge for same used was practically 75 per cent of the cost of new rail. Scrap released was credited at approximately market value. The average charges per mile of side track for rail renewals was about 25 per cent the cost per mile of main track.

Account 5.—*Other Track Material.* Practically 37 per cent of this account was account of frogs and switches, the major portion being to *turnout* frogs, hence due entirely to side tracks, although many existed in the main track. A careful analysis shows that one mile of side track costs practically the same as one mile of main track

Account 18.—*Roadway Tools and Supplies.* One mile of side track requires about one-third the cost of one mile of main track.

In the remaining accounts of Maintenance of Way and Structures the side track mileage rarely affects the amount of the account and can be neglected in economic calculation. The main track portion of these accounts per mile of main track can be obtained by dividing the total charge to each account by the equivalent main track mileage, the latter being the total main track mileage plus the product of side track mileage by the proper per cent of cost per side track mile for the given account.

The above accounts are all materially affected by volume of traffic except Account 2, Ballast, and Accounts 9 and 10, Bridges, Culverts, Over and Undergrade Crossings.

The train mile has been commonly used as a traffic unit in economic studies in the past, but it is illogical to use this unit as a measurement of wear and tear on the track owing to the wide limits in weights of trains that can be handled by the same locomotive on districts of different gradients. The ton mile would be the best unit considering total weights on the rails if freight traffic only

passed over the track, but passenger traffic also must be considered and owing to the higher velocity of trains the damage done per ton of passenger train is greater and the labor of maintaining track for the higher velocities is increased. With velocities equal, the damage done to track will vary about directly proportional to the load per axle and one ton of locomotive will create more disturbance to track than one ton of car and contents.

The following gives some average axle loads for the heaviest types of modern locomotives and for average loading for cars. It will be many years before the average locomotive loading reaches these figures, while the average car loading will probably increase:

Passenger Service.	Average load per axle.
Atlantic Locomotive	39,100
Pacific Locomotive	37,800
10-Wheel Locomotive	22,000
Average Passenger Train Car	22,000
Freight Service.	
Mikado Locomotive	48,500
Consolidation Locomotive	44,600
Mallet Comp. Locomotive	42,300
50-ton Capacity Gondola Car, loaded one way; return empty	22,500
Average 35 tons per car of freight train (above present average)	17,500

The present average of load per axle of freight and passenger locomotives is less than double the average load per axle of train.

In studying average maintenance expenses by divisions for a period of years on the large system previously mentioned it appeared that the best unit of traffic measurement of expense was what we will term the equivalent ton mile. The total equivalent ton miles would be the sum of the following:

Double the freight locomotive mileage times average weight per locomotive.
Four times the passenger locomotive mileage times average weight.
Total freight ton miles (cars and contents).
Double the passenger ton miles (cars and contents).

This unit considers that one ton of passenger car does double the injury of one ton of freight car, and that one ton of locomotive affects the track as much as two tons of the train back of the locomotive. This unit of measurement even best fits the increase of maintenance of buildings due to increase of traffic and consequent increase in number and size of buildings. Passenger traffic demands a higher type and better grade of maintenance than freight, and even a better type of shop buildings for repair.

With the exception of Account 4, Rails, there is a minimum expense for the accounts affected by volume of traffic due to depreciation and decay. This expense must be met to keep the road in shape for operation. The increase in expense above this minimum is practically directly proportional to the equivalent ton mileage passing over the tracks. There may be a slight loss of rails by corrosion, but its effect on the general account cannot be noticed and the cost can safely be considered directly proportional to the equivalent ton mileage.

Criticism may be made of adopting a traffic unit that involves the estimating of passenger train tonnage. Nothing can be done of value if the work of the Committee is to be based in the terms of statistics as kept at the present time. Net ton miles, freight and passenger train car mileage is kept, also road engine mileage separated between freight and passenger service. Weights of locomotives are a matter of record. The estimating covers the assumption of an average weight for empty freight cars, which at present is about 18 tons, and an average weight per car and load of passenger train cars. At the present time 44 tons per passenger train car of the average train will not lead to great error, and the average passenger train of the United States has approximately 5.3 cars per train. This last figure is not necessary for use where passenger train car mileage is available.

Early in the present year the Interstate Commerce Commission published a pamphlet, "A Preliminary Abstract of Statistics of Common Carriers for the Year Ended June 30, 1911." The information in this pamphlet is more complete with reference to operating data of individual roads than has heretofore been published.

The table herewith showing the items of costs of the maintenance accounts affected by traffic is deduced from data given by the Commission, using the ratios of costs per mile of side track as outlined to reduce to cost per mile of main track only. As only average weights of locomotives, excluding tender, were given, two-thirds of the weight was added to cover weight of tender and the same weight of engine was assumed for both passenger and freight service. The ton mileage was worked from net ton mileage and the mileage of the two classes of cars and road engines.

There is no attempt to place the cost of ties in dollars per mile of track, as there is probably no account in which there is a wider variety of materials or unit costs than in ties. Climatic conditions affect the tie question, particularly noticed when comparing the roads of the South with those of the North. It is evident that the roads using either properly treated woods or timber of a high grade, and protecting the ties from mechanical wear by heavy tie plates with good bearing area, are receiving good returns because of the practice.

In all of the accounts it must be recognized that some of the roads were above the normal in the various accounts and other roads below. The graphical charts show the points for the fifty-three roads and also a line showing the practical mean of all of the points. This line can be considered as representing the average present day cost for the given items. Taking the data from several years' operation of a railway, the following formula will give the average expense to maintain due solely to age and decay for the accounts where both decay and mechanical wear enter the question, and using the tabular values for the functions as deduced from these statistics for 1911 the average expense for any volume of traffic per mile of main track can be estimated:

A = Total main track mileage.
B = Total side track mileage.
C = Average annual charge to the given account.
P = Proportional charge per mile of side track as compared with charge for main track only.
X = Annual charge per mile of main track to keep in condition for proper operation covering the amount due to age or decay.
R = Proportion of X representing the additional charge per mile of main track for each million equivalent ton miles per annum.
M = Million ton miles traffic per annum per mile of main track.
E = Charge per annum per mile of main track only, for the given account.

$$E = \frac{C}{A + BP} = X + MRX = X\,(1 + MR)$$

$$\text{Then } X = \frac{C}{A + BP + MR\,(A + BP)}$$

The values given for P and R in the tables with conclusions are suitable to determine average value of X for the great bulk of the railroads of the country, providing a sufficient number of years' data is used to produce a normal average. For the exceptional cases where a large portion of total track mileage consists of busy industry spurs and sidings, suitable values for P must be ascertained.

The data given for ties is based on a study of renewals on different divisions of the same line with widely varying traffic. On track where ties were of a high grade timber or creosoted and with a large proportion of ties protected by heavy tie plates, the renewals in main track were 6.5 per cent of total in the track plus 0.3 per cent for each million equivalent ton miles traffic. This figure appears to fit very closely the northern half of the United States, where the roads have taken means to properly protect the ties. In the southern portion the per cent due to decay will be greater, but by multiplying the proper percentage by the value .046 per million equivalent ton miles, the average renewals can be approximated for cases where proper methods are used to retard mechanical wear. Each locality can determine within reasonable limits the value of the constant renewals required due to decay for the available timbers.

Account 4, Rail Renewals, apparently costs about $11.00 per mile of main track for each million ton miles and requires about 1.1 tons of new rail for this traffic. This figure will answer under present conditions of rail renewals and checks very closely with some data gathered on the equivalent ton mileage per mile of track during the life of 80-pound tangent rail on a busy double track division. The maximum equivalent tons over any of the rail was 147 millions. The tangent rail released was in condition for relayers or for re-rolling, and considering 110 million miles the average for this rail would make practically 1.1 tons per million equivalent ton miles.

According to custom, the maintenance charges are only for the weight released less the arbitrary credit for the usable released material, although heavier section may be used for replacements. The relayers when used to replace still lighter section on districts of less traffic will further reduce the maintenance charge, as the rail finally released fixes the final distribution of total cost between Maintenance and Betterments. It is apparent that as the average weight of rail approaches the modern heavier section that betterments will absorb a less proportion of expense of rail renewals and maintenance charges will be increased. Sufficient data is not at hand to show whether the heavier rail will withstand an equivalent increase in tonnage directly proportional to its weight. It can hardly be expected to do so, as head wear determines the necessity of renewals where rail sections are sufficiently stiff for the axle loads. The cost of rail renewals will probably be found to bear a different relation to volume of traffic in a very few years.

The other Maintenance of Way and Structures accounts affecting main track are for all practical purposes independent of the volume of traffic. Most of them are dependent on either milleage of main track or mileage of road. Tunnels, Bridges and Culverts and Over and Under Grade Crossings are dependent on topography of the country and materials of construction, and in comparing the relative economy of different locations the amount and character of tunnels and bridges on each must be considered in estimating the difference in maintenance costs.

The tables in the conclusions give the accounts under their respective headings. Other Maintenance of Way and Structures accounts may be ignored, as they bear practically no relation to location.

Average values for any of these main accounts can be obtained from Interstate Commerce Commission Reports for the leading roads in all sections of the country.

The foregoing covers only the foundation of the work for analyzing the effect of changes in physical characteristics on Maintenance of Way and Structures accounts. It can be seen that distance affects nearly all of the accounts mentioned and that volume of traffic affects only a portion of them. Curvature affects only the rail renewals and roadway and track accounts with a very slight addition to tie renewals, providing that good substantial tie plates having large bearing area are used. It must be assumed that proper details of construction are used in the initial work in estimating relative values of different lines. Future study of the Committee should be to determine the effect of curvature on the accounts mentioned and then take up the study with reference to Maintenance of Equipment and Conducting Transportation expenses.

ACCOUNTS AFFECTED BY MAIN TRACK MILEAGE.

No.	Account	Remarks.
2	Ballast	For full ballasted track this varies with the quality of ballast and cost laid down at side of track.
7	Removal of Snow and Ice	Varies widely, depending on climatic conditions.
13	Signals (Block Signals only)	Present average cost $125.00 per mile with average of one signal to the mile. Curvature may necessitate additional signals.
20.	Stationery and Printing	

ACCOUNTS AFFECTED BY MILEAGE OF ROAD.

11.	Grade Crossings Fence Cattle Guards and Signs	Mileage of main track affects this account slightly, but variation is most directly in proportion to miles of road.
12.	Snow Fences and Snow Sheds	Varies widely, dependent on climatic conditions.
14	Telegraph and Telephone Lines	Varies slightly per mile of road, depending on number of wires.

ACCOUNTS AFFECTED SOLELY BY TOPOGRAPHICAL FEATURES.

8	Tunnels	The expense of these items depends on the number size and character of the structures on each location.
9	Bridges Trestles and Culverts	
10	Over and Under Grade Crossings	

The following are the conclusions with reference to the present study:

Conclusions.

Maintenance of Way and Structures:

1. The problems of economic location deal only with main track in the majority of cases, side tracks entering into the question only where differences in distance is so great as to necessitate additional side tracks.

2. The annual charge per mile of main track for any account embracing both main and side track can be approximated for any operated line by the following formula:

A = Total average main track mileage.
B = Total average side track mileage.
C = Average annual charge to the account.
P = Proportional charge per mile of side track as compared with charge per mile of main track.
E = Average annual charge per mile of main track only.

$$E = \frac{C}{A + BP}$$

The average value of P is shown in the table, but for roads located almost wholly within dense mining or manufacturing districts requiring an exceedingly large proportion of busy side and spur tracks, the values would be higher and should be determined.

3. The accounts covering maintenance of main track do not all vary by the same general law, but vary most directly according to the following groups:

(a) Affected by both miles of track and volumes of traffic.
(b) Affected by miles of main track.
(c) Affected by miles of road.
(d) Affected by local topographical features.

Therefore no single unit of measurement of relative maintenance expense is applicable to all accounts in comparing the relative economies of two locations. The tables show the groupings of the accounts under their proper heading.

4. One ton of passenger train does more damage to track than one ton of freight train, and the locomotive creates more disturbance than an equal weight of cars and contents. Until data is available to correctly estimate the relative damage, it is recommended that the following ratios be used in estimating effect of traffic on the accounts in Group (a):

One ton of passenger car and contents produces approximately the effect of two tons of freight car and contents.
One ton of locomotive produces approximately the effect of two tons of the balance of its train.

The total ton mileage reduced to terms of ton miles of freight car and contents is termed the *equivalent ton mileage.*

Most of the accounts in Group (a) have a constant maintenance expense due to age and decay plus an additional expense, depending on volume of traffic. This additional expense per mile of main track varies most directly with the *equivalent ton mile.* The equivalent ton mileage can be approximated by adding together the following:

Net freight ton mileage.
Double the freight locomotive mileage times average weight in tons.
Freight train car mileage times the average weight of empty cars (at present about 18 tons).

	ACCOUNT	Avg. Values P	Avg. Values R	1911 Avg. Values X	1911 Avg. Values RX	REMARKS
1	Superintendence	0 33	0.44	$18.	$ 8.	
2	Ties (Based on number used)	0.7	0.046	Varies		Cost, quality and climatic conditions vary widely.
2	Ties (Based on Cost)	0 5	0.046	Varies		Local conditions must determine value of X. Curvature affects charges but lightly where protected by proper plates and fastenings.
4	Rails	0.25		0		Present average annual charge per mile of main track is $11.00 per million ton miles or 1 1 tons new rails for same traffic. Curvature affects this account.
5	Other Track Material	1		0		Present average annual charge per mile of main track is $10.00 per million ton miles. Affected slightly by curvature
6	Roadway and Track	0 33	0 245	$200.	$49.	Affected by curvature.
16	Buildings	0	2 4	10	24	Affected only where distance or increased volume of traffic makes additional buildings necessary.
18	Tools and Supplies	0 33	0 40	5	2	

Values of P. & R. for Use in Formula Below.

Double the passenger train car mileage times the average weight of car and contents (at present about 44 tons).

Four times the passenger engine mileage times the average weight in tons.

5. The average annual expense per mile of main track due to age or decay for the accounts in which this item enters can be approximated for any road by the following formula:

E = Charge per annum per mile of main track only.
X = Annual charge per mile of main track due to age or decay.
R = Proportion of X covering the additional charge per annum per mile of main track for each million equivalent ton miles.
M = Million equivalent ton miles per annum per mile of main track.
Then from above and equation in Conclusion 2.

$$E = X + MRX = X(1 + MR) = \frac{C}{A + BP}$$

$$X = \frac{C}{A + BP + MR(A + BP)}$$

Average values for P and R are shown in the tables.

Revision of Manual.

Your Committee recommends that Conclusion 2, page 436 of the Manual, be changed to read: Numerous tests demonstrate that there is no absolute value for train resistance. For practical purposes freight train resistance can be considered constant between velocities of 7 and 35 miles per hour.

That Conclusions 3 and 7 be eliminated and the matter under sub-head 1 on page 618 of this report be substituted; also the table on page 615.

That for Conclusion 4 there be substituted Conclusions 1-4 on pages 620 and 621.

That Conclusions 8 and 9 be renumbered 7 and 8, respectively.

APPENDIX A.

Ratio of Locomotive Equivalent Ton Mileage to Total.

The accompanying table shows the per cent of Equivalent Ton Mileage that the locomotive bears to the total equivalent ton mileage of its class of traffic for the roads given in the table in the body of the report. Owing to the fact that both tables were made on the average weight of locomotives of the road, passenger and freight engines considered the same, the percentage shown for freight locomotives is probably lower than it should be and the percentage for passenger service higher since the average freight locomotive weighs more than the passenger types.

This table is given as information to show the approximate amount of damage done by the locomotive for each class of traffic, on the basis of one ton of locomotive doing double the damage of one ton of the balance of its train. The question of the exact ratio of damage is an intricate one and would require more data than the committee has at present. There is no strong probability that the average axle load of locomotive and tender will reach the exceptionally heavy loading given for the extra heavy Mikado type in the report for many years, even if it ever does, and the modern consolidation will, in the majority of cases, represent the average to be considered in estimating values of locations.

It is interesting to note that by the proposed method of equivalent ton miles the passenger locomotive does as much damage as the balance of its train, while the freight locomotive does about one-third as much as the balance of its train on the average. The two extremes of freight service are represented by the Pittsburgh & Lake Erie Railroad, which with its low grades averages about 16.5 tons of cars and contents to each ton of locomotive, and the Denver & Rio Grande Railroad with its very heavy mountain gradients averages about 3.9 tons cars and contents per ton of locomotive. The extremes in passenger service are the New York, Chicago & St. Louis Railroad, averaging 3.15 tons passenger cars to one ton of locomotive, and the Chicago & Eastern Illinois Railroad, averaging 1.88 tons per locomotive ton.

ROAD	Frt	Pass	ROAD	Frt.	Pass.
Penn R R	20	55	L & N R R	27	50
D. L. & W R R	23	49	So. Pac., and G H & S. A.	23	49
Penn. Co	21	51	A T & S. F. Ry	28	53
P & L. E R R	11	57	Un. Pac., O.S.L., O.W R &N.	24	51
N. Y. C & St L. R. R.	19	39	N C & St L Ry	29	47
P & R. Ry	21	57	C G W. R R	24	54
Vandalia R. R	24	50	C B & Q R R.	22	48
L. S. & M. S. Ry	20	52	C & N.-W. Ry	26	51
N Y C & H R R. R	24	53	C R I. & P. Ry	27	52
C R R. of N J	28	56	Can. Pac. Ry	25	45
Northern Cen. Ry	21	54	M K. & T. Ry (Incl. Texas).	26	48
N. & W. Ry	24	55	Southern Ry	28	53
C. C. C. & St L.	23	62	C. St. P. M & O Ry.	27	44
Erie R. R	22	51	C. M. & St. P Ry.	26	47
Lehigh Valley R R	21	54	Nor. Pac. Ry	24	53
B & O R. R.	26	57	Great Nor. Ry	21	48
P B & W R R	24	52	St. L. & S. F. R. R.	29	53
D & H. Co	28	60	Pere Marquette R. R	23	53
C C. C & St. L. Ry	22	54	Texas & Pac. Ry	24	48
C. & O. Ry.	18	55	Mo. Pac., St. L. I. M.& S. Ry	26	54
Wabash R. R	22	51	D & R G. R. R.	34	50
C. & A. R. R.	23	54	Y & M. V. R R	17	40
Ills. Cen. R. R	22	49	Seaboard Air Line Ry	28	48
Long Island R. R.	40	41	Atlantic Coast Line R. R.	24	47
D M. & N. Ry	15	61	M. St. P. & S. Ste M. Ry.	23	49
C & E I. R. R	19	63	Cen. of Georgia Ry.	24	41
Mobile & Ohio R R	25	50			

Per Cent. Locomotive Equivalent Ton Mileage Bears to Total Equivalent Ton Mileage of Its Class of Traffic.

In former practice the locomotive has been frequently considered as affecting track in a fixed ratio to the balance of its train, but examples above will show the inconsistency of using such methods. It is to be hoped that data will become available to fix the factor with more certainty than the one assumed in this report.

Discussion.

A. K. Shurtleff (C., R. I. & P. Ry.): There has been some criticism of this report, and there seems to be an idea that the subject can be reduced to an exact science, but such is not the case. The equations given represent operating conditions, and different roads will probably find it necessary to use different coefficients. We hope to provide a formula simple enough for field use, and a more refined formula for office use. Passenger roads require much higher maintenance than freight roads; therefore maintenance charges should be heavier against passenger trains.

W. J. Wilgus (consulting engineer): I have been much interested in this report, especially the part relating to the segregation of maintenance expenses chargeable to passenger and freight service. I believe there is no greater effect on track from a passenger ton mile than from a freight ton mile, provided the effect of refrigerator car drippings, heavy wheel concentrations, imperfections of equipment, nosing of locomotives at low speed, etc., are taken into account. Freight car springs are stiffer, and therefore freight cars give the track a greater shock than passenger cars. Many freight trains are run at high speed. The difference between the effect of a locomotive ton and a car ton is probably not as great as is imagined.

In the absence of precise data it is not fair to say that under average conditions a gross ton of passenger train creates even the same destructive action as a gross ton of freight train.

L. C. Fritch (C. G. W. R. R.): This subject is so involved that it is impossible to find a formula that will fit all conditions. I believe that 35 mile upper limit of constant resistance is too high, and 20 miles is nearer the truth, from my experience. The economic loading is somewhat below the maximum, and I believe our railways are wasting much money in overloading trains.

F. S. Stevens (P. & R. Ry.): It seems to me a self-evident fact that the most economical tonnage to handle is that which can be delivered from point to point in a given time, entirely disregarding whether the locomotive wears out in a year or ten years.

C. P. Howard (I. C. R. R.): I have recently used the data in this report for calculating time and fuel consumption for a division of 130 miles. Where it was possible to handle a 5,000-ton train at 35 m. p. h. it was found 4,000 is about the economical limit.

F. S. Stevens (P. & R. Ry.): The theoretical tonnage rating in many cases will be impractical on account of interference with other traffic.

Conclusion 2 under Revision of Manual was adopted as revised.

L. C. Fritch (C. G. W. R. R.): I do not see how we are to use (3) and (7), which states "after 15 minutes" the values obtain.

A. K. Shurtleff (C., R. I. & P. Ry.): The starting resistance is negligible in warm weather.

G. D. Brooke (B. & O. R. R.): The first 15 minutes do not affect results appreciably, even if figured without starting resistance.

A. K. Shurtleff (C., R. I. & P. Ry.): The locomotive has a greater power to overcome starting under the low speed than it would have under the maximum speed on that grade.

J. G. Sullivan (C. P. Ry.): The effect of expensive grade revision is often nullified by a change in superintendents, the successor deciding the former loading was too heavy and dropping back to loadings about the same as before revision. The Engineering and Operating departments should work closer together, but I don't think this Committee should have any restrictions placed on them in studying the transportation features.

The conclusions were adopted as suggested in the second paragraph of the Committee's recommendations for change of the Manual.

J. L. Campbell (E. P. & S. W. Ry.): The engineers lay out the railway and they should take pains to see that an efficient use is being made of the plant.

J. B. Jenkins (B. & O. R. R.): I believe that the resistance for curvature increases per degree with increased curvature. The reason tests seem to show the opposite is because the freight trains proceed around a high degree curve at more nearly the speed for which the curve is elevated.

A. K. Shurtleff (C., R. I. & P. Ry.): The extra .05 per cent in (5) is to help out freight service which is rounding the curve at reduced speed and increased resistance because of too much elevation for that speed. The reason the compensation is less on a short curve is because all of the train is not on the curve at one time.

Prof. W. G. Raymond (Iowa University): I believe, on theoretical grounds, the curve resistance varies per degree with the degree of curvature.

Conclusions 1 to 4 were adopted to supersede (4) in the Manual.

A. K. Shurtleff (C., R. I. & P. Ry.): The method of analyzing maintenance of way expenses is not deemed perfect, but it is, we believe, a start in the right direction.

Conclusion (1) (Analysis of Maintenance of Way and Structure Accounts) was adopted and Conclusions (2) and (3) were accepted as information.

L. S. Rose (C., C., C. & St. L. Ry.): In regard to (4) I do not believe, as a general proposition, that the passenger traffic is twice as hard on track as freight traffic.

L. C. Fritch (C. G. W. R. R.): I think we should be very sure of our ground before we recommend the adoption of (4).

A. K. Shurtleff (C., R. I. & P. Ry.): The Committee had no exact information on this subject.

M. L. Byers: I do not believe a fast freight running at 60 m. p. h. is different in effect from a passenger train at same speed. You must maintain your tracks in much better shape for high speeds, and the cost of raising a joint ⅛ inch is practically the same as raising one ½ inch. The maintenance cost is therefore much higher on passenger tracks.

C. E. Lindsay (N. Y. C. & H. R. R. R.): On our four-track lines we have recently been forced to run some freight trains on what were exclusively passenger track, and the effect has been very marked.

Conclusions (4) and (5) were referred back to the Committee.

WOODEN BRIDGES AND TRESTLES.

I. L. Simmons, *Chairman;* W. S. Bouton, *Vice-Chairman;* H. Austill, Jr., F. E. Bissell, R. D. Coombs, E. A. Frink, E. A. Hadley, Hans Ibsen, Henry S. Jacoby, P. B. Motley, D. W. Smith, W. F. Steffens, H. B. Stuart.

The Association directed that the outline of committee work for the year 1912 be as follows:

(1) Report on formulæ for use in determining the strength of sheet piling.

(2) Report on fire protection of wooden bridges and trestles.
(3) Complete report on the use of guard-rails for wooden bridges and trestles.

The Committee was divided into sub-committees and a different topic assigned to each. The work during the forepart of the year consisted of the collection and tabulation of data.

A meeting was held in Chicago on the 2d of November, 1912, at which were present Messrs. I. L. Simmons, Chairman; W. S. Bouton, Vice-Chairman; E. A. Frink, Hans Ibsen, D. W. Smith and H. B. Stuart. The different sub-committees furnished the information which they had collected. The points contained in the information were discussed and the Committee desires to make the following report and recommendations:

On subject (1) the Committee reports progress.

On subject (2), Report on Fire Protection of Wooden Bridges and Trestles, the Committee does not deem it advisable to make any recommendations, but submits its report as information.

On subject (3) the Committee makes the following recommendations:

Conclusions.

(1) It is recommended as good practice to use guard timbers on all open-floor bridges, and same should be so constructed as to properly space the ties and hold them securely in their places.

(2) It is recommended as good practice to use guard-rails to extend beyond the ends of the bridges for such a distance as required by local conditions, but that this length in any case be not less than fifty feet; that guard-rails be fully spiked to every tie and spliced at every joint, the guard-rail to be some form of a metal guard-rail.

(3) It is recommended that the guard timber and inner guard-rail be so spaced in reference to the track-rail that a derailed truck will strike the guard-rail without striking the guard timber.

(4) The height of the inner guard-rail to be not over one inch less than the running-rail.

During the year a communication was received from Mr. Lindsay, suggesting the substitution of the term "guide-rail" for "guard-rail," and after due consideration by the Committee it was decided not to recommend the change.

Recommendations for Next Year's Work.

Your Committee recommends that the following subjects be assigned for the ensuing year:

(1) Complete report on formulæ for use in determining the strength of sheet piling.

(2) Report on the subject of docks and wharves.

Discussion.

Conclusion (1) was adopted.

L. S. Rose (C., C., C. & St. L. Ry.): I think it is going too far to specify a guard-rail for every bridge. If this was carried out logically, we would have a guard-rail on every embankment.

C. E. Lindsay (N. Y. C. & H. R. R. R.): I suggested the use of "guide-rails" to designate the rails which we are now discussing. The usual meaning of guard-rail is one to prevent derailments. "Guide-rails" would better designate those rails which guide the trucks after derailing. I am opposed to using guard-rails at all bridges. At a slow-speed point a guard-rail is of doubtful value.

C. F. Loweth (C., M. & St. P. Ry.): The use of guard-rails at every bridge is an unnecessary expense.

J. L. Campbell (E. P. & S. W. Ry.): I think the wooden outside guard-rail tends to slew a truck around, and think such guard-rails should be eliminated.

C. E. Smith (M. P. Ry.): The cost to our railway to comply with the Committee's suggestion would be $1,250,000. I do not know of a case where an inner guard-rail would have prevented or lessened the effect of a derailment.

I. L. Simmins (C., R. I. & P. Ry.): The length of the bridge does not make any difference, for as bad a wreck might occur on a 15-foot structure as on a 500-foot structure. The location does make a difference, and the question in particular cases should be determined by the man in charge.

L. S. Rose (C., C., C. & St. L. Ry.): I think the question of inner guard-rails is largely a matter of sentiment. I have seen derailments where they had no effect.

G. W. Andrews (B. & O. R. R.): I take exception to that statement. We have had a number of derailments where the guard-rail prevented the engine and possibly a number of cars from going down the embankment.

L. S. Rose (C., C., C. & St. L. Ry.): I move the Committee revise the clause striking out where they are to be used.

H. T. Porter (B. & L. E. R. R.): I second the motion. We find heavy cars are not guided, but tear out the guard-rails.

Conclusion (2) was referred back to the Committee after being put to a vote.

C. F. Loweth (C., M. & St. P. Ry.): I suggest inserting in (3) to make it read, "guard-rail when used," etc.

The Committee accepted the suggestion.

J. B. Jenkins (B. & O. R. R.): I would like to change (4) to read, "the top of the inner guard-rail shall not be higher than or more than 1 inch below the running-rail."

The Committee accepted this suggestion.

UNIFORM GENERAL CONTRACT FORMS.

W. G. Atwood, *Chairman;* J. C. Irwin, *Vice-Chairman;* C. Frank Allen, E. F. Ackerman, Thos. Earle, John P. Congdon, R. G. Kenly, E. H. Lee, C. A. Paquette, H. C. Phillips, J. H. Roach, C. A. Wilson, H. A. Woods.

The Committee was instructed to complete its report and submit the General Construction Contract.

In accordance with the suggestions made at the convention in 1912, the Secretary of the Association had a draft of the proposed form printed and sent a copy to the senior officer of each railway having membership in the Association, with a request for a criticism of the contract by the Legal Department. There were seventy replies received, which may be classed as follows:

Number of Replies.	*Nature of Replies.*
One	Thought it impractical to draw a Uniform Contract Form.
Six	Preferred their own forms and made no other comments.
Thirty-five	Approved of form, except in a few cases, where the lien clause was criticised.
Three	Did not criticise, two of these being Canadian roads.
Twenty-five	Made more or less extended criticisms.

The Secretary tabulated the replies, both the criticisms and the corresponding clauses of other contracts. This information was used by the Committee in revising the forms submitted for criticism. As this compilation would fill about one hundred and twenty-five printed pages, it was considered undesirable to publish it. However, it is available at the office of the Secretary in case any of the members wish to consult it. Many of the criticisms concerned the detailed wording of the various clauses, and but few of them disapproved of any of the provisions as a whole.

The plan of having an agreement form of two pages to be used by itself for unimportant work and to act as a binder for the "general conditions, specifications and plans" was approved by the convention of 1912. This agreement form as presented was also approved. As the result of legal criticisms received the Committee desires to recommend three amendments to this form, as follows:

In the third paragraph insert the words "except as hereinafter specified," making this paragraph read: "The Contractor shall furnish all necessary transportation, except as hereinafter specified, materials, superintendence, etc."

In the first line below the blanks left for the description of the work, insert after the word "attached" the words "identified by the signatures of the parties hereto," and eliminate the word "as," making this paragraph read: "In accordance with the plans hereto attached, identified by the signatures of the parties hereto, or herein described, and the following general conditions, etc."

Add to the next paragraph the words "time being of the essence of this contract," making this paragraph read: "The work covered by this contract shall be commenced ..... and be completed on or before the ..... day of ..... 191..., time being of the essence of this contract ....."

The Committee presents for approval:

(1) Amendments to form "A" as above.
(2) Form "B" as presented.

Recommendations.

(1) That Standing Committees which have prepared specifications be instructed to harmonize them with the approved contract form by the elimination of provisions which duplicate or nullify clauses of the contract form.

(2) That the Special Committee on Uniform General Contract Forms be discharged on account of the completion of the work assigned to it.

CONSTRUCTION CONTRACT.

A—Agreement.

THIS AGREEMENT, made this ..... day of ..... in the year ..... by and between ..... party of the first part, hereinafter called the Contractor, and ....., party of the second part, hereinafter called the Company.

WITNESSETH, That, in consideration of the covenants and agreements hereinafter mentioned, to be performed by the parties hereto, and of the payments hereinafter agreed to be made, it is mutually agreed as follows:

The Contractor shall furnish all the necessary transportation, except as hereinafter specified, materials, superintendence, labor and equipment, and shall execute, construct and finish, in an expeditious,

substantial and workmanlike manner, to the satisfaction and acceptance of the Chief Engineer of the Company .....
.....
.....
in accordance with the plans hereto attached, identified by the signatures of the parties hereto, or herein described, and the following general conditions, requirements and specifications, forming part of this contract.

The work covered by this contract shall be commenced .....
..... and be completed on or before the ..... day of ..... 191...., time being of the essence of this contract .....
.....
.....

And in consideration of the completion of the work described herein, and the fulfillment of all stipulations of this agreement to the satisfaction and acceptance of the Chief Engineer of the Company, the said Company shall pay, or cause to be paid, to said Contractor, the amount due the Contractor, based on the following prices:
.....
.....

This agreement shall inure to the benefit of and be binding upon the legal representatives and successors of the parties respectively.

IN WITNESS WHEREOF, The parties hereto have executed this agreement in ..... the day and year first above written.

WITNESS:

....
....

B—General Conditions.

1. *Bond.* The Contractor agrees, at the time of the execution and delivery of this contract, and before the taking effect of the

J. C. Irwin, Chairman, Uniform General Contract Forms.

same, to furnish and deliver to the Company a good and sufficient bond of indemnity to the amount of ..... dollars, as security for the faithful performance, by the Contractor, of all the covenants and agreements on the part of the Contractor contained in this contract. The security in such bond of indemnity must be satisfactory and acceptable to the Company.

This bond shall remain in force and effect in such amount, not greater than that specified, as shall be determined by the Chief Engineer, until the final completion and acceptance of the work.

2. *Contractor's Understanding.* It is understood and agreed that the Contractor has, by careful examination, satisfied himself as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and all other matters which can in any way affect the work under this contract. No verbal agreement or conversation with any officer, agent or employe of the Company, either before or after the execution of this contract, shall affect or modify any of the terms or obligations herein contained.

3. *Intent of Plans and Specifications.* All work that may be called for in the specifications and not shown on the plans, or shown on the plans and not called for in the specifications, shall be executed and furnished by the Contractor as if described in both these ways: and should any work or material be required which is not denoted in the specifications or plans, either directly or indirectly, but which is nevertheless necessary for the proper carrying out of the intent thereof, the Contractor is to understand the same to be implied and required and shall perform all such work and furnish any such material as fully as if they were particularly delineated or described.

4. *Permits.* Permits of a temporary nature necessary for the prosecution of the work shall be secured by the Contractor. Permits for permanent structures or permanent changes in existing facilities shall be secured by the Company.

5. *Protection.* Whenever the local conditions, laws or ordinances require, the Contractor shall furnish and maintain, at his own cost and expense, necessary passageways, guard fences and lights and such other facilities and means of protection as may be required.

6. *Rights of Various Interests.* Wherever work being done by Company forces or by other Contractors is contiguous to work covered by this contract, the respective rights of the various interests involved shall be established by the Engineer, to secure the completion of the various portions of the work in general harmony.

7. *Consent to Transfer.* The Contractor shall not let or transfer this contract or any part thereof (except for the delivery of material) without consent of the Chief Engineer, given in writing. Such consent does not release or relieve the Contractor from any of his obligations and liabilities under the contract.

2. *Superintendence.* The Contractor shall constantly superintend all the work embraced in this contract, in person or by a duly authorized manager acceptable to the Company.

9. *Timely Demand for Points and Instructions.* The Contractor shall not proceed until he has made timely demand upon the Engineer for, and has received from him, such points and instructions as may be necessary as the work progresses. The work shall be done in strict conformity with such points and instructions.

10. *Report Errors and Discrepancies.* If the Contractor, in the course of the work, finds any discrepancy between the plans and the physical conditions of the locality, or any errors in plans or in the layout as given by said points and instructions, it shall be his duty to immediately inform the Engineer in writing and the Engineer shall promptly verify the same. Any work done after such discovery, until authorized, will be done at the Contractor's risk.

11. *Preservation of Stakes.* The Contractor must carefully preserve bench marks, reference points and stakes, and in case of wilful or careless destruction he will be charged with the resulting expense, and shall be responsible for any mistakes that may be caused by their unnecessary loss or disturbance.

12. *Inspection.* All work and materials shall be at all times open to the inspection, acceptance or rejection of the Engineer or his duly authorized representative. The Contractor shall provide reasonable and necessary facilities for such inspection.

13. *Defective Work or Material.* Any omission or failure on the part of the Engineer to disapprove or reject any work or material shall not be construed to be an acceptance of any defective work or material. The Contractor shall remove, at his own expense, any work or material condemned by the Engineer, and shall rebuild and replace the same without extra charge, and in default thereof the same may be done by the Company at the Contractor's expense, or, in case the Chief Engineer should not consider the defect of sufficient importance to require the Contractor to rebuild or replace any imperfect work or material, he shall have power, and is hereby authorized to make an equitable deduction from the stipulated price.

14. *Insurance.* The Contractor shall secure in the name of the Company and for its benefit policies of fire insurance on such structures and in such amounts as shall be specified by the Chief Engineer not exceeding .....

15. *Indemnity.* The Contractor shall indemnify and save harmless the Company from and against all claims, demands, payments, suits, actions, recoveries and judgments of every nature and description brought or recovered against it, by reason of any act or omission of the said Contractor, his agents or employes, in the execution of the work by or in consequence of any negligence or carelessness in guarding the same.

16. *Settlement for Wages.* Whenever, in the opinion of the Chief Engineer, it may be necessary for the progress of the work to secure to any of the employes of the Contractor any wages which may then be due them, the Company is hereby authorized to pay said employes the amount due them or any lesser amount, and the amount so paid them, as shown by their receipts, shall be deducted from any moneys that may be or become payable to said Contractor.

17. *Liens.* If at any time there shall be evidence of any lien or claim for which the Company might become liable and which is chargeable to the Contractor, the Company shall have the right to retain out of any payment then due, or thereafter to become due, an amount sufficient to completely indemnify the Company against such lien or claim, and if such lien or claim be valid, the Company may pay and discharge the same, and deduct the amount so paid from any moneys which may be or become due and payable to the Contractor.

18. *Work Adjacent to Railroad.* Whenever the work embraced in this contract is near the tracks, structures or buildings of this Company, or of other railroads, the Contractor shall use proper care and vigilance to avoid injury to persons or property. The work must be

so conducted as not to interfere with the movement of trains or other operations of the railroad; or, if in any case such interference be necessary, the Contractor shall not proceed until he has first obtained specific authority and directions therefor from the proper designated officer of the Company and has the approval of the Engineer.

19. *Risk.* The work in every respect shall be at the risk of the Contractor until finished and accepted, except damage or injury caused directly by Company's agents or employes.

20. *Order and Discipline.* The Contractor shall at all times enforce strict discipline and good order among his employes, and any employe of the Contractor who shall appear to be incompetent, disorderly or intemperate, or in any other way disqualified for or unfaithful to the work entrusted to him, shall be discharged immediately on the request of the Engineer, and he shall not again be employed on the work without the Engineer's written consent.

21. *Contractor Not to Hire Company's Employes.* The Contractor shall not employ or hire any of the Company's employes without the permission of the Engineer.

22. *Intoxicating Liquors Prohibited.* The Contractor, in so far as his authority extends, shall not permit the sale, distribution or use of any intoxicating liquors upon or adjacent to the work or allow any such to be brought upon, to or near the line of the railway of the Company.

23. *Cleaning Up.* The Contractor shall, as directed by the Engineer, remove from the Company's property and from all public and private property, at his own expense, all temporary structures, rubbish and waste materials resulting from his operations.

24. *Engineer and Chief Engineer Defined.* Wherever, in this contract, the word Engineer is used, it shall be understood as referring to the Chief Engineer of the Company, acting personally, or through an assistant, duly authorized, in writing, for such act by the Chief Engineer, and wherever the words Chief Engineer are used it shall be understood as referring to the Chief Engineer in person and not to any assistant engineer.

25. *Power of Engineer.* The Engineer shall have power to reject or condemn all work or material which does not conform to this contract; to direct the application of forces to any portion of the work which, in his judgment, requires it; to order the force increased or diminished, and to decide questions which arise between the parties relative to the execution of the work.

26. *Adjustment of Dispute.* All questions or controversies which may arise between the Contractor and the Company, under or in reference to this contract, shall be subject to the decision of the Chief Engineer, and his decision shall be final and conclusive upon both parties.

27. *Order of Completion; Use of Completed Portions.* The Contractor shall complete any portion or portions of the work in such order of time as the Engineer may require. The Company shall have the right to take possession of and use any completed or partially completed portions of the work, notwithstanding the time for completing the entire work or such portions may not have expired; but such taking possession and use shall not be deemed an acceptance of the work as taken or used, or any part thereof. If such prior use increases the cost of or delays the work, the Contractor will be entitled to such extra compensation or extension of time, or both, as the Chief Engineer may determine.

28. *Changes.* The Company shall have the right to make any changes that may be hereafter determined upon in the nature or dimensions of the work, either before or after its commencement, and such changes shall in no way affect or void this contract. If such changes make any change in the cost of the work, an equitable adjustment shall be made by the Chief Engineer to cover the same.

29. *Extra Work.* No bill or claim for extra work or material shall be allowed or paid unless the doing of such extra work or the finishing of such extra material shall have been authorized in writing by the Engineer.

The price for such work shall be determined by the Chief Engineer, who may either fix a unit price or a lump-sum price, or may, if he so elects, provide that the price shall be determined by the actual cost, to which shall be added ..... per cent to cover general expense and superintendence, profits, contingencies, use of tools, Contractor's risk and liability. If the Contractor shall perform any work or furnish any material which is not provided for in this contract, or which was not authorized in writing by the Engineer, said Contractor shall receive no compensation for such work or material so furnished, and does hereby release and discharge the Company from any liability therefor.

If the Contractor shall proceed with such extra work or the furnishing of such extra material after receiving the written authority therefor, as hereinbefore provided, then such work or material, stated in the written authority of the Engineer, shall be covered, governed and controlled by all the terms and provisions of this contract, subject to such prices as may be agreed upon or fixed by the Chief Engineer.

If the Contractor shall decline or fail to perform such work or furnish such extra material as authorized by the Engineer in writing, as aforesaid, the Company may then arrange for the performance of the work in any manner it may see fit, the same as if this contract had not been executed, and the Contractor shall not interfere with such performance of the work.

30. *Property and Right of Entry.* The Company shall provide the lands upon which the work under this contract is to be done, except that the Contractor shall provide land required for the erection of temporary construction facilities and storage of his material, together with right of access to the same.

The Contractor shall not ship any material or equipment until he has received written notice from the Engineer that he may proceed with said work or any part thereof.

31. *Unavoidable Delays; Extension of Time on Parts of Work.* If the Contractor shall be delayed in the performance of the work from any cause for which the Company is responsible, he shall, upon written application to the Chief Engineer at the time of such delay, be granted such extension of time as the Chief Engineer shall deem equitable and just.

32. *Suspension of Work.* The Company may at any time stop the work, or any part thereof, by giving ten (10) days' notice to the Contractor in writing. The work shall be resumed by the Contractor in ten (10) days after the date fixed in the written notice from the Company to the Contractor so to do. The Company shall not be held liable for any damage or anticipated profits on account of the work being stopped, or for any work done during the interval of suspension. It will, however, pay the Contractor for expense of men and teams necessarily retained during the interval of suspension, provided the Contractor can show that it was not reasonably practicable to move these men and teams to other points at which they could have been employed. The Company will further pay the Contractor for time necessarily lost during such suspension at the rate of ..... per cent per annum on the estimated value of all equipment and fixtures owned by the Contractor and employed on the work which are necessarily idle during such suspension, said rate of ..... per cent per annum being understood to include depreciation, interest and insurance. But if the work, or any part thereof, shall be stopped by the notice in writing aforesaid, and if the Company does not give notice in writing to the Contractor to resume work at a date within ..... of the date fixed in the written notice to suspend, then the Contractor may abandon that portion of the work so suspended and he will be entitled to the estimates and payments for such work so abandoned, as provided in Section Thirty-eight (38) of this contract.

33. *Expediting Work, Correcting Imperfections.* If the Chief Engineer of the Company shall at any time be of the opinion that the Contractor is neglecting to remedy any imperfections in the work or is not progressing with the work as fast as necessary to insure its completion within the time and as required by the contract, or is otherwise violating any of the provisions of this contract, said Engineer, in behalf of the Company, shall have the power, and it shall be his duty to notify the Contractor to remedy such imperfections, proceed more rapidly with said work or otherwise comply with the provisions of this contract.

Annulment. The Company, if not at fault, may give the Contractor ten (10) days' written notice, and at the end of that time if the Contractor continues to neglect the work, the Company may provide labor and materials and deduct the cost from any money due to Contractor under this agreement; and may terminate the employment of the Contractor under this agreement and take possession of the premises and of all materials, tools and appliances thereon, and employ such forces as may be necessary to finish the work. In such case the Contractor shall receive no further payment until the work shall be finished, when, if the unpaid balance that would be due under this contract exceeds the cost to the Company of finishing the work, such excess shall be paid to the Contractor; but if such cost exceeds such unpaid balance, the Contractor shall pay the difference to the Company.

Company May Do Part of Work. Upon failure of the Contractor to comply with any notice given in accordance with the provisions hereof, the Company shall have the alternative right, instead of assuming charge of the entire work, to place additional forces, tools, equipment and materials on parts of the work for the purpose of carrying on such parts of the work, and the cost incurred by the Company in carrying on such parts of the work shall be payable by the Contractor and such work shall be deemed to be carried on by the Company on account of the Contractor, and the Contractor shall be allowed therefor the contract price. The Company may retain the amount of the cost of such work, with ..... per cent added, from any sum or sums due or to become due the Contractor under this agreement.

34 (a). *Annulment Without Fault of Contractor.* The Company shall have the right at any time, for reasons which appear good to it, to annul this contract upon giving thirty (30) days' notice in writing to the Contractor, in which event the Contractor shall be entitled to the full amount of the estimate for the work done by him under the terms and conditions of this contract up to the time of such annulment, including the retained percentage. The Contractor shall be reimbursed by the Company for such expenditures as in the judgment of the Chief Engineer are not otherwise compensated for, and as are required in preparing for and moving to and from the work; the intent being that an equitable settlement shall be made with the Contractor.

(b) *Notice; How Served.* Any notice to be given by the Company to the Contractor under this contract shall be deemed to be served

if the same be delivered to the man in charge of any office used by the Contractor, or to his foreman or agent at or near the work, or deposited in the postoffice, postpaid, addressed to the Contractor at his last known place of business.

(c) *Removal of Equipment.* In case of annulment of this contract before completion from any cause whatever, the Contractor, if notified to do so by the Company, shall promptly remove any part or all of his equipment and supplies from the property of the Company, failing which the Company shall have the right to remove such equipment and supplies at the expense of the Contractor.

35. *Failure to Make Payments.* Failure by the Company to make payments at the times provided in this agreement shall give the Contractor the right to suspend work until payment is made, or at his option, after thirty (30) days' notice in writing, should the Company continue to default, to terminate this contract and recover the price of all work done and materials provided and all damages sustained, and such failure to make payments at the times provided shall be a bar to any claim by the Company against the Contractor for delay in completion of the work.

36. *Monthly Estimate.* So long as the work herein contracted for is prosecuted in accordance with the provisions of this contract, and with such progress as may be satisfactory to the Chief Engineer, the said Chief Engineer will, on or about the first day of each month, make an approximate estimate of the proportionate value of the work done and of material furnished or delivered upon the Company's property at the site of the work, up to and including the last day of the previous month. The amount of said estimate, after deducting..... per cent, and all previous payments, shall be due and payable to the Contractor at the office of the Treasurer of the Company on or about the 20th day of the current month.

37. *Acceptance.* The work shall be inspected for acceptance by the Company promptly upon receipt of notice that the work is ready for such inspection.

38. *Final Estimates.* Upon the completion and acceptance of the work the Chief Engineer shall execute a certificate over his signature that the whole work provided for in this agreement has been completed and accepted by him under the terms and conditions thereof, whereupon the entire balance found to be due to the Contractor, including said retained percentage, shall be paid to the Contractor at the office of the Treasurer of the Company within ..... days after the date of said final certificate. Before the time of payment of said final estimate the Contractor shall submit evidence satisfactory to the Chief Engineer that all payrolls, materials, bills and outstanding indebtedness in connection with this work have been paid.

Discussion.

L. C. Fritch (C. G. W. R. R.): I don't think it is fair to let the Chief Engineer decide disputes. They should be submitted to an arbitration board.

Hunter McDonald (N. C. & St. L. Ry.): My experience has been that arbitration is useless. You can get a case decided more quickly and more satisfactorily in the courts.

C. P. Howard (I. C. R. R.): My recollection is that eminent attorneys have stated the Engineer's decision would stand, as the designated arbitrator, unless it was clearly proven that there was fraudulent motives or he had made a mistake.

W. G. Atwood (L. E. & W. R. R.): The Chief Engineer is designated to have this power so the work can be carried on without delay.

L. C. Fritch (C. G. W. R. R.): I think we should change (30) to read instead of "of men and teams," "of men, material and equipment furnished by the Contractor."

The Committee accepted this suggestion.

Edward Gray, Jr. (C. & O. Ry.): I would suggest (15) read: "By reason of any act of omission of the Contractor, or in consequence of any negligence or carelessness in guarding same."

The Committee accepted this suggested reading.

The Committee, in accordance with a suggestion, changed (1), eliminating "until the final completion or acceptance of the work," and leaving a blank space.

WOOD PRESERVATION.

Earl Stimson, *Chairman;* E. H. Bowser, *Vice-Chairman;* G. M. Davidson, H. B. Dick, C. F. Ford, Dr. W. K. Hatt, V. K. Hendricks, George E. Rex, E. A. Sterling, C. M. Taylor, Dr. H. von Schrenk, T. G. Townsend.

The Board of Direction assigned to your Committee the following subjects:

(1) Continue investigation of proper grouping of different timbers for antiseptic treatment.

(2) Investigate the merits of various preservatives, giving special attention to oil from water-gas tar, and to the use of refined coal-tar in creosote oil.

(3) The advisability of revising the specifications for fractionation of creosote oil.

(4) Recommend forms for the inspection of preservative processes.

These subjects were assigned each to a Sub-Committee for consideration.

In addition to the subjects specifically assigned for this year's consideration by the Board of Direction, your Committee continued investigations on the following two subjects assigned in previous years, but on which no final report was made:

(1) GROUPING OF TIMBERS FOR ANTISEPTIC TREATMENT.

In the report last year your Committee stated the fundamental principles governing the grouping of timbers for treatment. These were adopted by the Association for publication in the Manual. It was the consensus of opinion that further recommendations could not be made until an extensive series of experiments had been conducted, which would indicate the proper practice at stated locations, and with timber from specific regions. An outline of points to be covered by experimental work in different regions was prepared and sent out to the members of the Sub-committee on Grouping, and some investigative work has been in progress during the year. Owing, however, to the long time required to reach definite conclusions and because of the difficulty of arranging for sustained experimental work along uniform lines, no data are available which would justify changing or adding to the fundamental principles outlined last year.

Some of the best authorities express the opinion that, owing to the variations in the character of the same kind of wood in different regions, the problems of grouping must be worked out at each individual treating plant, and that statements regarding detail practice which would have general application cannot be made.

Another view of the matter, which has been expressed, is that the next step is to determine the laws governing the penetration of creosote, from which the grouping of timbers according to natural resistance may be made. As the committee has no facilities for studies of this kind, and since the wood-preserving industry looks to the U. S. Forest Products Laboratory and other institutions devoted to technical investigations for reports along this line, it is recommended that the attention of the United States Forest Products Laboratory be called to the desirability of a study of the regional variation in wood structure by species, in reference to the absorption of preservatives.

Your committee will continue its investigation along these lines during the coming year.

(2) THE MERITS OF PRESERVATIVES.

(a) The Use of Refined Coal Tar in Creosote Oil: The sub-committee to which this subject was assigned made an exhaustive research for facts pertaining thereto upon which the committee might base a report and definite recommendations. The result was such that the committee was not able to reach a conclusion and is not in position at this time to present a report with recommendations to the association.

The committee, therefore, reports progress, and will continue the consideration of this subject.

(b) The Use of Oil From Water-Gas Tar: So far as your committee has been able to learn, water-gas creosote has not been extensively used under its own name as a wood preservative, and there is very little information to be found as to its efficacy.

There are a few piles treated with it and driven in the harbor at Norfolk, Va. These waters are badly infested with Teredo, and the piles are said not to have been attacked, although they have been there about three years. Professor Alleman has a tie at Swarthmore which was treated with water-gas creosote and was in service nine years at Porto Rico. This tie is still sound. The Public Service Corporation of New Jersey has been using water-gas creosote for several years for treating ties. These ties should show in about two years whether the treatment is good or not. They are now treating a large number of pine ties with straight water-gas creosote furnished by the United Gas Improvement Company of Philadelphia. One of the large creosoting companies has recently obtained a patent for treating wood with a mixture of water-gas creosote and coal-tar creosote, and one of the large railroad companies is contemplating the use of a mixture of water-gas creosote and coal-tar creosote for ties. The United States Forest Service has some specimens treated with water-gas creosote placed at West Pascagoula and Gulfport, Miss.; the latter put in the water in March, 1912. None of the specimens has been there long enough to give any results.

It seems that the principal objection to water-gas creosote has been to its unauthorized use as an adulterant in coal-tar creosote. Its use, however, is now increasing in legitimate mixtures, and, while it is too early to get any results, it seems that a number of people favor using at least a mixture of this oil with coal-tar creosote.

It is recommended that the investigation of this subject be continued for another year.

(3) CONSIDERATION OF THE SPECIFICATIONS FOR FRACTIONATION OF CREOSOTE OIL.

For some years past your committee has had under consideration the relative merits of the flask and retort for the fractionation of creosote oil. For the purpose of obtaining information on this point, and on which to base consideration of further revisions in the specifications for fractionation, your committee sent samples of various creosote oils to different railroads for fractionation by the various methods. A full statement, including charts and tables of results of these fractionations is presented as Appendix "A" to this report. Based thereon, your committee recommends that no change be made in the adopted specifications for fractionation of creosote oil.

(4) FORMS FOR REPORTING INSPECTION.

Two forms for reporting inspection of treatment are submitted. Form "A" provides a record of the treatment and the determination of the absorption of the penetration by gage readings. Form "B" provides a record of the determination of the absorption by weighing.

These forms are intended as a general guide for reporting and keeping records of the inspection of the treatment of timbers, and may be varied to suit any special kind of treatment.

The following is explanatory of the gage readings, designated by letter on Form "B":

Reading "A"—Is the reading of the measuring tank gage before the oil is put into the cylinder.

Reading "B"—Is the tank gage reading when the cylinder is completely filled.

Reading "C"—Is the tank gage reading when the pumping of the oil into the cylinder is stopped.

Reading "D"—Is the tank gage reading after all the oil from the charge is returned to the measuring tank.

Reading "A" minus "D," corrected for temperatures, gives the number of gallons used in the charge.

Reading "B" minus "C" give the number of gallons pumped into the timber after the cylinder is filled and is used to give the gross absorption for light processes where oil is taken out of the timber by an initial air pressure, or by a final vacuum, or both. There will be a discrepancy in this gross absorption, due to the amount of oil absorbed by the timber while cylinder is being filled.

L. A. Downs, Chairman Committee on Ties.

RECORDS FROM SERVICE TESTS.

As Appendix "B" to this report will be found the Record from Service Tests, brought up to date and extended to include a number of additional tests not shown on the records submitted with the report of last year.

Conclusions.

It is recommended:

(1) That no change be made in the adopted Specifications for the Fractionation of Creosote Oil.

(2) That the forms "A" and "B" for reporting the Inspection of Treatment of Timbers, and the notes explanatory of the gage readings on Form "A," as given under sub-head four (4), "Forms for Reporting Inspection," be adopted for insertion in the Manual.

Outline of Work for 1913.

Your committee recommends:

(1) Continue investigations of the merits as a preservative of oil from water-gas and the use of refined coal-tar in creosote oil.,

(2) Continue the compilation of available information from Service Tests.

(3) Continue the investigation of the proper grouping of the different timbers for antiseptic treatment.

(4) Report on methods of accurately determining the absorption of creosote oil.

(5) That the Board of Direction assign the work of drawing up a Standard Specification for Timber for Treatment to a Joint Committee of the Committee on Wood Preservation and the Committee on Grading of Lumber.

Discussion.

Herman von Schrenk: To test the specifications for fractionating creosote oil, two kinds of oil were sent out to a number of railways and fractionated by the A. R. E. A. process, and by flash. The A. R. E. A. tests showed a smaller variation in results, and we could find no evidence of improvement in the flash method.

Form "B" was adopted for inserting in the Manual.

TIES.

L. A. Downs, Chairman; G. W. Merrell, Vice-Chairman; H. W. Brown, W. J. Burton, L. C. Hartley, E. D. Jackson, H. C. Landon, F. R. Layng, E. R. Lewis, R. J. Parker, L. M. Perkins, J. G. Schillinger, G. D. Swingly, D. W. Thrower, H. S. Wilgus, Louis Yager, E. C. Young.

The Board of Direction assigned the following subjects to the Committee on Ties:

(1) Report on the effect of design of tie-plates and track spikes on durability of ties.

(2) Continue study of the stresses to which cross-ties are subjected, and determine size required.

(3) Report on economy in labor and material effected through use of treated ties compared with untreated ties.

(4) Continue the compilation of information as to the use of metal, composite and concrete ties.

The report on the effect of the design of tie plates and spikes on the durability of ties is given in Appendix A, and is submitted as information.

The report on the subject of stresses to which crossties are subjected is given in Appendix B.

Your committee also reports progress on the subject of economy in labor and material effected through use of treated ties compared with untreated ties.

In Appendix C is given a compilation as to the use of metal, composite and concrete ties.

Spacing Face to Face	Name of Company Recommending	Mileage of each Railroad	Mileage for each Spacing	Percentage
6"	American Creosoting Company			
7"	N. Y. C.—G. W. Kittredge		2,829	5%
8"	C. & E. I.		966	2%
10"	B. & A.	628		
10"	G. T.—Burton & Allrug	4,757		
10"	I. C.	2,245		
10"	K. & M.	175		
10"	N. & W. (G. W. Merrell—See 11")	1,931		
10"	P. & R. (F. S. Stevens—See 13")	1,509		
10"	P. & L. E. (J. A. Atwood—See 13")	215	11,430	20%
11"	E. P. & S. W.	902		
11"	N. & W. (C. S. Churchill—See 10")	1,051		
11"	Q. M. & S.	192	2,145	5%
12"	C. B. & Q.	8,966		
12"	A. T. & S. F.	10,206		
12"	C. R. I. & P. (J. M. Brown—See 13")	8,020		
12"	P. & L. E. (E. F. Wendt—See 10")	215		
12"	W. P. T.	64	27,473	47%
13"	C. R. I. & P. (Garrett Davis—See 12")	8,020		
13"	P. & R. (R. B. Abbott—See 10")	1,509	9,529	16%
13	L. V. (as a maximum)		1,432	2%
15	W. M.		543	1%
10" to 12"	L. S. & M. S.		1,863	3%
			58,960	100%
	Total mileage of Association		281,000	
	Percentage here represented, 23%.			

Tie Spacing Recommended by Different Companies.

Conclusions.

Your committee has given the subject of stresses to which cross-ties are subjected an exhaustive study, covering a period of two years, and after conferences with a number of leading members of the Association, finds no reason to change its conclusions submitted in 1912, and given on page 331 of Volume 13, and resubmits them for adoption.

The conclusions of the committee are as follows:

(1) It is impracticable to perform experiments to determine size of cross-ties, for the following reasons:

(a) Character of subgrade varies radically on the same road and in different parts of the country.

(b) Kind of ballast varies widely.

(c) Necessary depth of ballast varies with weight of axle loads, as well as density of traffic.

(d) Necessary distance between face of ties varies with weight of axle load, as well as density of traffic.

(e) Kinds of timber used for ties vary in different sections of the country.

(f) Width of base of rail (or weight of rail) and use of tie-plates.

(g) Treated or untreated ties, crushing stress and durability.

(h) Amount of labor spent on track maintenance.

(i) Drainage.

(2) It is recommended that the report on the effect of design of tie-plates and track spikes on durability of ties be received as information.

(3) It is recommended that the report on metal, composite and concrete ties be received as information.

APPENDIX A.

Report on the Effect of Design of Tie-Plates and Spikes on the Durability of Ties.

A circular letter requesting information relative to this subject was sent to members of the Association. The following is a list of the questions asked:

(1) Do you use flat, longitudinal flange, transverse flange, pronged or corrugated tie-plates?

(2) Please send plan of your standard tie-plate, and give method of applying.

(3) Do you use screw or cut spikes?

(4) In your opinion, how far should tie-plate extend outside base of rail to overcome side thrust, and what should be total bearing area? Give reasons for your conclusions.

Replies were received from 61 railroads. These have been tabulated in statement form, and herewith submitted to the Association, as information. The number of roads using only one design of tie-plate and kind of plate used, are:

Longitudinal flange	16
Transverse flange	8
Flat	5
Pronged	4
Corrugated	11

The number of roads using two designs of tie-plates and kind of plates used, are:

Longitudinal flange and flat	3
Longitudinal flange and pronged	1
Longitudinal flange and corrugated	1
Transverse flange and pronged	1
Transverse flange and corrugated	1
Flat and pronged	1
Flat and corrugated	1
Pronged and corrugated	1

The number of roads using three designs of tie-plates and kind of plates used, are:

Longitudinal flange, transverse and flat	1
Longitudinal flange, transverse and corrugated	2
Longitudinal flange, flat and corrugated	1
Longitudinal flange, pronged and corrugated	1
Transverse flange, flat and pronged	1

The number of roads using four designs of tie-plates and kind of plates used, are:

Longitudinal flange, transverse, pronged and corrugated	1

The committee was unable to obtain any definite information bearing on the relative effect of the different designs of tie-plates and spikes on the life of ties, but it is thought that experiments, which are now being conducted, will throw some light on this subject in the near future.

(Appendix "B" is a progress report and is omitted for lack of space.)

APPENDIX C.

Continue Study of the Stresses to Which Cross-Ties are Subjected, and Determine Size Required.

This committee was assigned in 1911-12 the topic "Size of cross-ties required for the stresses to which they are subjected." The report will be found on pp. 301 to 370 and discussion on pp. 951 to 964 of Vol. 13, 1912. The report, with its conclusions, was accepted as information and referred back to the committee for further investigation and with enlargement of the scope of the topic.

The assigned topic resolves itself into two parts, viz:

(1) Continue the study of the stresses to which cross-ties are subjected; and

(2) Determine the size required.

In order to have an expression of opinion as to the best method for handling the topic, a letter was sent to twenty-seven members of the Association. There is quite a divergence of opinion. "Track Deformation," by Cuenot, to which reference is made later, covers very well many of the suggested methods mentioned in said letters for solving the second half of the topic.

The first part of the assigned topic may be touched upon to the extent of spacing of the ties.

Exhibit F, pp. 312 to 329, Vol. 13, question 1-E, contains answers respecting spacing of ties, a tabulation of which is as follows, to-wit:

The preponderance of the mileage voting is in favor of twelve-inch face to face; the next in favor is ten-inch; the next thirteen-inch. The recommendation of this committee for 1912 was ten to twelve-inch, and the above table substantiates its recommendation.

The Ballast Committee published a translation of "Gravel as Ballast," by C. Bräuning, pp. 267 to 285, Vol. 13. Mr. Bräuning's conclusions, which are in accord with your committee's recommendations, are as follows:

"Of greater importance than the width of the tie is the spacing of the ties. As the spacing is decreased two advantages are derived; first, the unit pressure is decreased; secondly, the carrying capacity of the roadbed is increased. It is just within the limits of tie spacing usually considered that the relation a-b (a=distance face to face of tie; b=depth of tie) ranging from 3½ to 2 (spacing 35-inch and 19½-inch center to center) that the carrying capacity increases at a high rate. The limiting feature of decreasing tie spacing is the ability to tamp the ties properly. Ties 6½ inches in height can still be tamped with convenience when separated 13½ inches. But this 23-inch from center to center is the lowest limit. This is the one most ceffctive and simplest means of increasing the strength of the roadbed and to utilize it to the fullest advantage, especially on roadbeds which are fully loaded, is urgently recommended."

Mr. Byers, 11-49, Vol. 1, 1911, International Railway Association, says "20-inch center to center of ties small as practicable." With an 8-inch tie the spacing face to face is 12 inches.

Therefore, your committee feels that its conclusions are fully in line with Mr. Bräuning's recommendation, though prepared without knowledge of either Messrs. Bräuning's or Byer's conclusions.

Vol. 13, pp. 306 and 307, gives a table of different number of ties per 30-ft. rail, the percentage of roads using 6x8x8 and table giving the different sizes of cross-ties in current use. The divergence of practice is undoubtedly largely due to varying conditions in different localities and to a tendency to "follow the leader." The latter is probably nearer the mark, as the tendency in American railroading has been in the past, and only now is being broken away from, for the railroad heads always to compare the engineering department recommendations with practice on other roads, with the result that in many lines our progress has been slow.

Discussion.

The report was accepted as information without discussion.

SIGNS, FENCES AND CROSSINGS.

C. H. Stein, Chairman; G. E. Boyd, Vice-Chairman; R. B. Abbott, H. E. Billman, E. T. Brown, J. T. Frame, C. M. James, L. C. Lawton,

C. H. Stein, Chairman Committee on Signs, Fences and Crossings.

G. L. Moore, J. B. Myers, F. M. Patterson, C. H. Splitstone, W. F. Strouse, W. D. Williams.

The following subjects were assigned by the Board of Direction for consideration:

(1) Report on the relative advantages of the different kinds of fence posts, with definite recommendations.

(2) Report on the best form of track construction and flangeways at paved street crossings and in paved streets, with definite recommendations.

(3) Continue the investigation of ways and means for securing a proper quality of fence wire to resist corrosion and secure durability.

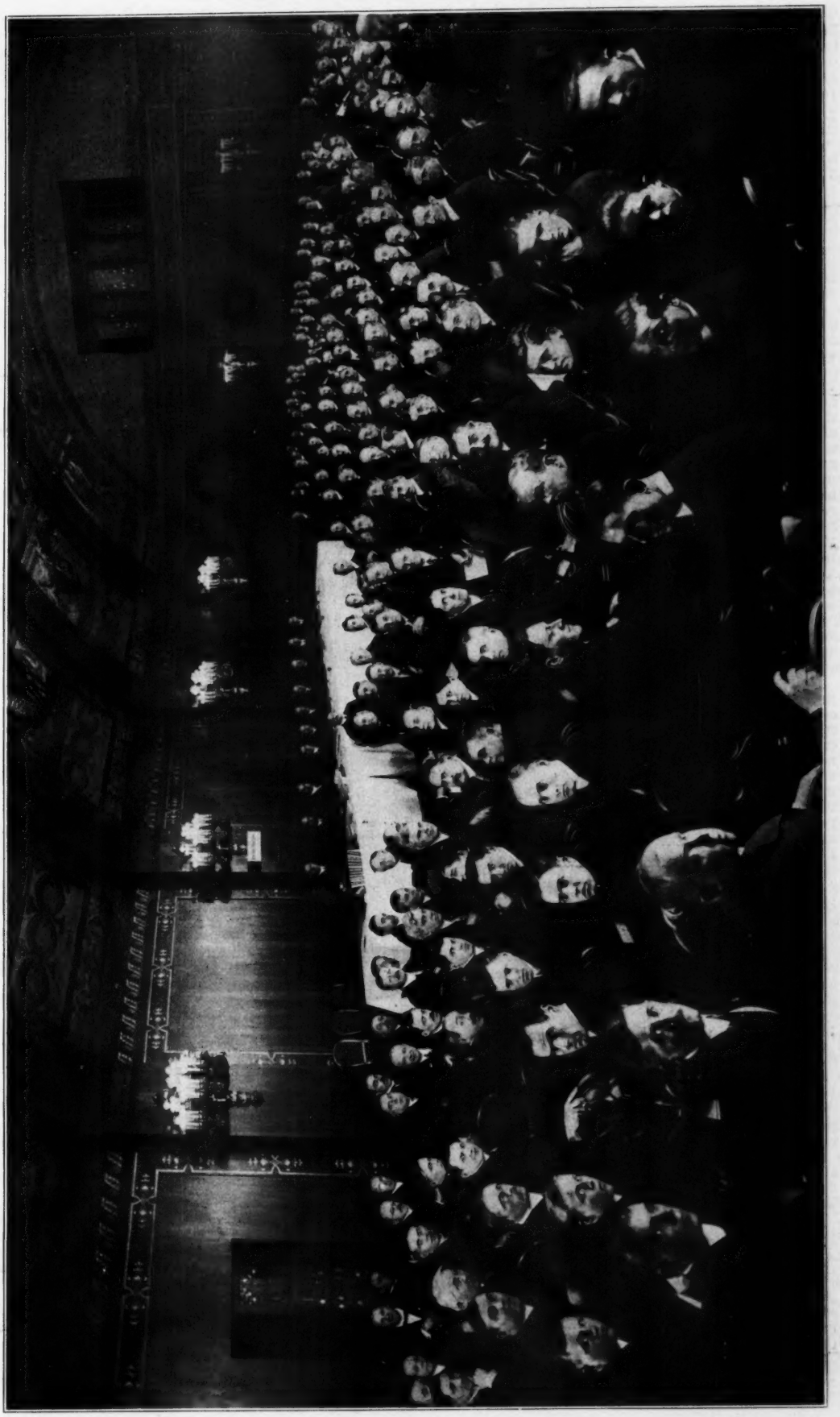
Your committee has corresponded with the various railroads of the United States, as well as the manufacturers of material, and has also endeavored to learn the practices of foreign countries. It now begs to submit the following report:

(1) RELATIVE ADVANTAGES OF THE DIFFERENT KINDS OF FENCE POSTS.

Replies were received from 44 railroads, with the folowing information as to kind of post used, cost, life of same, etc.;

It will be observed from the foregoing that the various roads use the different kinds of timber indigenous to their geographical position as follows:

Cedar	32
Chestnut	7
Locust	9



Photograph Taken at the Convention During Report of Committee on Signs, Fences and Crossings.

Oak	9
Bois D'Arc	5
Catalpa	1
Oregon Fir	1
Juniper	1
Tamarack	1
Burnettized Pine	1
Mulberry	1

There are certain species of each of the above woods that are not suitable for fence posts, but doubtless must be used because they are cheap and native to the locality.

Life of Posts.

Doubtless some give little heed to the particular species of such timber that they use, and assume that any species of that genus has about the same life. This is manifestly incorrect as is demonstrated by the oak family. The inferior grades of oak have only a life of from 2 to 4 years, while a good white oak has a life in our northern climates of from 10 to 12 years at least. Certain classes of oak last much longer in their native regions than in other localities to which they are transported for use. This principle applies with equal force to every other class of timber.

In reviewing the replies of the various roads we find that the consensus of opinion, based upon experience of the users, is that the different classes of timber have an average life as indicated below:

Red Cedar	18 years
White Cedar	15 "
Chestnut	12 "
Yellow Locust	20 "
Black Locust	20 "
White Oak	10 "
Bois D'Arc	25 "
Catalpa	15 "
Juniper	15 "
Mulberry	15 "

Climatic influences have an important bearing upon this phase of the case, and may lengthen or shorten the life of a particular kind of wood, dependent upon locality in which used. It is not feasible in most cases to recommend any particular kind of timber for a given territory, as the source of supply may be so distant as to preclude its use economically. It is the prevailing practice to use such timber as is native to the country and thus most easily obtainable. According to information received, the cost of the various kinds of wood posts is:

	Range.	Average.
Red Cedar	15c to 25c	22c
Cedar	7c " 20c	14c
White Cedar	12c " 15c	14c
Chestnut	10c " 27c	20c
Locust	15c " 40c	25c
Yellow Locust	20c " 38c	30c
Black Locust	15c " 25c	20c
White Oak	11c " 40c	20c
Bois D'Arc	13c " 17c	15c
Catalpa	15c " 25c	20c
Juniper	6c " 10c	8c
Mulberry	13c " 17c	15c

It will be observed that the relative cost to life of post ranges from one-half cent to two cents per year of life, the Bois D'Arc and the Juniper being the cheapest posts, but so rare that a more general use is impossible.

It was of interest to know to what extent wooden posts were subject to destruction by fire. Replies indicated that this varied by from 1 per cent to 5 per cent, with the exception of one road which reported a loss of 30 per cent from this cause. We think it fair to assume that the average loss by fire is around 3 per cent.

Only two roads so far as we can learn make mention of having used any metal posts, and then but to a limited extent. In the one case bar iron ¼ in. x 2 in. was used and in the other old boiler tubes. We have reason to believe, however, that quite a number of roads, not replying to our circular, are trying out a proprietary metal post. Several styles of steel right-of-way fence posts are on the market. Their exploitation has just begun in the last year or two, and any statement as to their efficiency and economy could be but vague and from the manufacturers' standpoint alone. Greater experience may demonstrate their utility, but thus far we have no data upon them, and can only give some computations from one of the manufacturers, which might be of interest for study from the viewpoint of railway economy. These figures, while prepared for a certain style of post only, if reliable, will no doubt be equally accurate for any other style of metal post, built along similar lines, and others are generally so designed. In order that the membership may have the manufacturers' explanation of the merits of the steel post for their further consideration, we give the statement of the case in substance according to one with whom we have had the matter under discussion:

Steel Posts cost	23.03 cents
Cost of setting	1.30 "
Total	24.33 "
Estimated life	30 years

Based upon above figures, steel posts set one rod apart cost 81 cents per year.

The cost of setting wood posts is estimated at 5.8 cents each. The following table is based on wood posts costing from nothing up to 20 cents each, and is intended to show what the life of wooden posts must be at different first costs to be as cheap as the steel post:

Cost of Post.	Cost of Setting.	Total Cost.	Years it must last to be as cheap as steel.
0 cents	5.8 cents	5.8 cents	7.1 years
5 "	5.8 "	10.8 "	13.3 "
8 "	5.8 "	13.8 "	17. "
10 "	5.8 "	15.8 "	19.5 "
12 "	5.8 "	17.8 "	21.9 "
15 "	5.8 "	20.8 "	25.6 "
17 "	5.8 "	22.8 "	28.1 "
18.53 "	5.8 "	24.33 "	30. "
20 "	5.8 "	25.8 "	31.8 "

The above figure would indicate that wood posts costing 15 cents would have to have a life of 25.6 years and those costing 20 cents a life of 31.8 years to be as cheap as steel.

To be of economic worth for right-ofway protection, a fence post must posses the following qualities: Durability, Practicability, Efficiency and the price must be right. Inquiry develops that one man can set in a day from 15 to 35 wooden line posts. To be conservative, 30 posts per day per man is assumed as the unit of work. Estimating wages at $1.75 per day places the cost of setting a wood post at 5.8 cents. The cost of post is estimated at 12 cents, resulting in an entire outlay of 17.8 cents. Experience is to have demonstrated that three men can readily set from 390 to 640 steel posts per day, or 130 to 213 per man—130 posts per man is taken as the basis of calculation with wages at $1.75 per day. This places the cost for setting a steel post at 1.3 cents. Cost of steel post 23.03 cents, plus cost of setting 1.3 cents, resulting in entire outlay, 24.33 cents.

	Railroad.	1 Kind of Post	2 Life of Post.	3 Cost of Post.	4 Destroyed by Fire.
1	Alberta Central	Tamarack & Cedar.		19.9c	
2	A. T. & S. F. System	Cedar & Bois D'Arc.	15-25 Yrs.	15c	
3	Balt. & Ohio	Cedar, Locust & Chestnut	12 Yrs.	Cedar 15c Locust 15c Chestnut 12c	None.
4	Bangor & Aroostook	Cedar.	15-20 Yrs.	8-12c	1%
5	uff., Roch. & Pittsburgh	Cedar.	18 Yrs.	18c	Very Small.
6	Canadian Pacific	Cedar.	15 Yrs.	11c	Very Small.
7	Central of New Jersey	Chestnut.	14 Yrs.	18c	
8	Chicago, Burlington & Quincy	Red Michigan Cedar.			
9	Chicago Great Western	White Oak.	10 Yrs.	60c	
10	Chicago, Peoria & St. Louis	White, Post & Fin Oak. Honey Locust & Cedar.	Oak 4 Yrs. Locust 7 Yrs. Cedar 15 Yrs.	11c	30%
11	Cincinnati, Hamilton & Dayton	Cedar.		13½c	
12	Cincinnati Northern	White Cedar.	12 Yrs.	18c	⅞ of 1%
13	Cleveland, Akron & Cincinnati	Locust & Chestnut.		Locust 16-18c Chestnut 10c	Considerable.
14	Denver & Rio Grande	Red Cedar	15 Yrs.	25c	
15	Duluth & Iron Range	Cedar.	15-20 Yrs.	12c	3%
16	Duluth, Missabe & Northern	White Cedar.	17 Yrs.	12c	
17	El Paso & Southwestern	Burnettized Pine			
18	Fort Worth & Denver City	Bois D'Arc.	25 Yrs.	15c	Small.
19	Grand Rapids & Indiana	Cedar.	17 Yrs.	10½c	5%
20	Illinois Central	Red Cedar	10-18 Yrs.	16-18c	
21	Kanawha & Michigan	Cedar	15 Yrs.	20½c	1%
22	Kansas City Terminal	Cedar		7½ Split 14c 10" Round 60c	
23	Lake Erie & Western	Cedar.	10-15 Yrs.	15c	
24	Lake Shore & Michigan South-ern	Cedar.	20 Yrs.	15c	
25	Long Island	Yellow Locust.	15-20 Yrs.	38c	6%
26	Louisville & Nashville	Red cedar, Black Locust & Catalpa.	10-35 Yrs.	14-25c	5%
27	Maine Central	Cedar.	15 Yrs.	10c	Very Small
28	Mississippi River & Bonne Terre	Northern Yellow Cedar. Southern Red Cedar.	15 Yrs.	18-30c	2-3%
29	N. Y. C. & H. R.	Cedar & Chestnut.	Cedar 17 Yrs. Chestnut 13 Yrs.	8-17c 10-37c	11%
30	N. Y. N. H. & H.	Chestnut.	10 Yrs.	13c	No Record.
31	Norfolk Southern	White Oak & Red Cedar.	7-9 Yrs.	20c	Small.
32	Norfolk & Western	Locust.		15c	
33	Penn. Lines West, S. W.	Red Cedar.	15 Yrs.	25c	
34	Penn. Lines West, N. W.	Red Cedar, Locust & Chest-nut.	15 Yrs.	25c	
35	Philadelphia & Reading	Chestnut.	10-15 Yrs.	15-25c	Very Small.
36	Quebec, Montreal & Southern	Cedar.	15 Yrs.		Less than 1%
37	Richmond, Fred'bg & Poto-mac	Red Cedar & Yellow Locust.	Cedar 20 Yrs. Locust 20 Yrs.	20-28c	Very Small.
38	Rock Island Lines	Oak, Cedar & Bois D'Arc.	Oak 8-15 Yrs. Cedar 15-30 Yrs.	7 13c 10 22c	
39	St. Louis Southwestern	Mulberry, White Oak & Bois D'Arc.	Mulberry 15-20 Yrs. White Oak 10-12 Yrs. Bois D'Arc 45 Yrs.	13-17c	
40	San Pedro, Los Angeles & Salt Lake	Native Cedar or Oregon Fir.	8-12 Yrs.	18-21c &c for Split Pile Ends. 8-12c	Good Many.
41	Spokane International	Cedar.		Cedar 7c	
42	Spokane, Portland & Seattle	Cedar & Juniper	Cedar 8 Yrs. Juniper 15 Yrs.	Juniper 8c	None.
43	Texas Midland	Bois D'Arc.	Indestructible.	15c	1%
44	Western Maryland	Locust.	20 Yrs.	40c	

General Information on Wooden Fence Posts.

Comparative Cost of Steel and Wood.

Entire cost of steel post 24.33c; estimated life 30 years
Money worth 6 per cent.
Entire cost of wood post 17.80c; estimated life 12 years.

Expenditure for steel posts	24.33 cents
Expenditure for wood posts	17.80 "
Difference	6.26 "

Compound interest on 6.26 cents for 12 years amount to 13.06 cents. At the expiration of 12 years wood posts have failed and need renewal. 13.06 cents has been saved over cost of steel posts. This is equivalent

to purchasing 8.8 years more protection with wood. In other words, 24.33 cents expended for steel give 30 years of protection, while same amount expended for wood gives 12 years original life, plus 8.8 years interest on investment, or 20.8 years, a balance in favor of steel of 9.2 years. Viewing the matter from another angle, assuming that posts are set one rod apart, track protection costs per year as follows:

Steel Posts.		Wood Posts.	
Per Rod.....	$ .0081	Per Rod.....	$ .0117
Per Mile	2.59	Per Mile	3.74
Per 100 Miles.	259.00	Per 100 Miles..	374.00

Balance in favor of steel posts of

$ .0036 per rod per year.
1.15 per mile per year.
115.00 per 100 miles per year.

Other advantages claimed are no staples used; right-of-way may be burned over from time to time without injury to posts. No loss from accidental fires and no renewal on that account. Special end, corner and gate posts must be used in connection with the steel line post. No means are provided for bracing them so as to use them as end or corner posts. There is not enough steel in them to stand the strain of streching a heavy wire fence. The minimum amount of steel is used necessary to meet requirements of a right-of-way fence. The line and end posts are treated as distinct problems. In this they are not unlike posts made of other materials. The demands on the end and corner posts are entirely different from those on the line posts. The line post should possess a certain degree of flexibility, while end and corner posts must be absolutely rigid.

Comparative Cost of Steel and Wood End and Corner Posts:

Cost of End Post.....$1.62
Cost of Corner Post..... 2.30

Assuming it fair to say that twice as many end posts will be needed as corner posts, it places the average of the stretching post at $1.84 each. If $1.84, the cost of the steel corner post, bears the same relation to the cost of a good wooden corner post that the price of the steel line post bears to the price of the wooden post, then the economy is demonstrated. In order to determine whether or not this relation maintains, we resort to the following equation:

$$\frac{12c \text{ (cost of wood line post)}}{23.03c \text{ (cost of steel line post)}} = \frac{+ \text{ (cost of wood corner post)}}{\$1.84 \text{ (cost of steel corner post)}}$$

We find X = 96 cents, cost of wooden corner post, which appears to be a conservative estimate of the cost of a good wooden corner post. From a mathematical and perspective point of view, the manufacturer of the steel fence post appears to have made out a case that is worthy of continued and further close investigation. Time alone, under practical service conditions, can demonstrate if the figures are based upon substantial premises, and subject to corroboration. To be efficient and adequate, the steel posts must resist corrosion, must be sufficiently strong to withstand ordinary and accidental hard usage, must not heave from the ground in Winter, must remain firm and not loosen up, permitting fence to get out of proper alignment. The speedy extinction of our forest lands, the failure on the part of all concerned to encourage the practice of reforestation, hence its slow progress, which idea will some day receive more earnest consideration than now, but too late for the next generation to profit by it, caused the users of wooden fence posts to seek some efficient substitute. The steel fence post has not yet proved its merit in practice and at this time concrete with suitable reinforcement seems to offer the only solution to the problem. A growing appreciation of the rapid depletion of our woodlands, and the urgency of discovering a suitable material to replace that which is now so near extinction, has during the past several years enkindled a livelier interest in the experimentation with and development of the proper form of concrete fence post. The problem is simply one of design. It is recognized as a primary proposition that in order to secure a post of such weight that it can be readily handled, practically as easily as wood, that it must not be too heavy; hence, reinforcement is necessary to reduce the bulk of concrete. This reinforcement must bear a co-ordinate relation to the concrete and act in harmony with it. To produce this result it must be properly placed, and make a proper mechanical bond with it. It has been demonstrated that while concrete posts are not as strong as wooden ones, yet they are sufficiently so to meet all practical conditions. It has been a generally accepted fact that wooden posts are stronger than necessary, rather than that concrete posts are not strong enough. Furthermore, it is true that there is quite a period of time in the case of wooden posts before they have decayed to such an extent as to actually require renewal, during which they are no stronger, in fact, not as strong as a properly designed concrete post. The latter has the advantage, so far as present investigations have proceeded, that its strength increases with age. It is true that many forms of concrete posts have been put on the market that had no utility whatever. Such, however, has always been the experience with any new development, and we are profiting by the failures of the pioneers in the industry.

Your committee has gotten into touch with the various manufacturers of concrete fence posts, as well as the various railroads that are experimenting with them, so far as has been possible, and will endeavor to present some data relating to them. Not more than a dozen railroads are using concrete posts at this time in large quantities, but a large number are pursuing the subject with a view to their extensive use. In deference to some manufacturers, we would state that we have not been able to present cuts of all the different designs because of inability to secure plans or photographs, and in the case of those presented, the information is not as full as we would have desired for similar reasons.

"A" posts are 7 ft. long, and are usually made 5 in. x 5 in. at the bottom and 3 in. x 5 in. at the top. Reinforcing material consists of steel bars with a series of perforations. It is a waste product produced in the manufacture of machinery and is only considered scrap. It is sold for from 1¼ to 1½ cents per pound. The perforations, size, etc., are assorted, unless purchaser demands uniformity, in which event higher price is charged. Cost ranges from 20 cents to 35 cents per post, depending upon size, local conditions, proportion and quality of material.

"B" posts are made in lengths of 6½ ft. to 8 ft., are 3 inches square, and do not taper from butt to top, claim being made that taper is not necessary. Wire fence is fastened to post by winding an independent or the wire around post by Western Union twist method. Reinforcement consists of a piece of No. 20 gage sheet-steel, cut in six-inch widths and pressed as shown, giving a full eight inches of resisting face. Reinforcement for a 7 ft. post weighs 5 lbs. Posts are set with corner toward fence wire. They will thus stand considerably more of a shock received in a line perpendicular to the fence line or parallel therewith, on account of the increased depth of the concrete and the manner in which the reinforcement is placed in the post.

"C" posts are made in lengths desired, are triangular in section and reinforcement is a combination of pressed steel and steel rods. The molds or forms, of which there are two, are raised to and held in a vertical position, top of post down. Post tapers from bottom to top. The concrete is tamped by gravity, the settling and compacting being accomplished by constant jar of the mold during process of making post. The mold is lifted automatically and let drop on a solid foundation, continuing this motion as it receives the concrete.

"D" posts are made 7 ft. long and weigh from 50 to 60 lbs. Reinforcement consists of three ¼ in. rods. Post is triangular in form and rods are placed one in each corner, tied together at short intervals by perforated core plates.

"E" posts are made in lengths of from 6 ft. to 8 ft., varying by one-half foot to suit consumer. They are of "T" form and weigh from 85 to 90 lbs. They taper from bottom to top in every dimension. They are designed upon the principle of the "T" beam. Reinforcement consists of three No. 5 second rods or five No. 9 wires, cut and straightened and bent at right angles one inch from each end. Wires are slightly irregular in shape and are termed seconds, not because of inferior quality, but because they are pressed out of shape in manufacture, which produces better bond between them and the concrete. They are placed as near surface as possible, but exposure must be avoided. No device is used in placing them.

"F" posts are tapering, practically square in cross-section, being made in "U" shaped molds, with round back corners leaving flat face. The regular size line post tapers from 5x5 in. at base to 3x3 in. at top in lengths of 7, 7½ and 8 ft. Supplied also with a 5½ in. base and 3½ in. top, as well as 6 in. base and 4 in. top in 7½ and 8 ft. lengths, respectively. The regular 7 ft. line post, 5x5 in. at base and 3x3 in. at top, weighs 80 lbs. (½ in. and 1 in. size larger posts are about ⅛ and ½ larger respectively, than regular.)

Reinforcement for regular line posts, four lengths of ⅝ in. wide, No. 18 gage hoop steel, or No. 5 wire rod "seconds," placed at corners or turns, and about ¼ in. from the surface, full length of post. (Other sections of steel single, stranded and fabricated forms also used, varying according to size of posts). (No. 5 wire rod "seconds" referred to are imperfect in shape only, being slightly imperfectly round).

The post machines consist of batteries of 6 and 10 molds each, the latter recommended for large capacity plants. Also 20, 30 and 50 mold trucks for steam curing or economy of transportation.

"G" post is square in form, with slight taper on two sides from bottom to top. It is 7 ft. long, 3½ in. by 4½ in. at bottom and 3½ in. by 3½ in. at top. Reinforcement consists of center tube of 24 gage black iron, 75 in. in length, with four No. 9 wires tensioned over tub. Truss plates or spreaders engage the four wires in tension.

"H" posts are "T" shaped, are 6½ in. by 6½ in. at bottom and 4½ in. by 3½ in. at top and 8 ft. long. Reinforcement consists of three ¼ in. twisted steel bars, placed in the three corners of post.

"I" posts are circular in form, tapering from bottom to top. Bottom diameter is 5½ in., top diameter is 4 in., and posts are 7 ft. long, weighing 121 lbs. Reinforcement consists of five or six (as desired), upright No. 8 crimped bright Bessemer wire, with No. 14 annealed cross wires to hold the uprights in place, and costs from $0.068 to $0.081 per post.

"J" post is "T" shaped, but entirely with rounded corners, and is tapered from 4 in. at the top across the face, and 4½ in. from front

to back, to 6¾ in. across the face at bottom, and 6½ in. from front to back. Posts are 7 ft. 4 in. long. Another feature is a foot or extension on that part of the post imbedded in the ground. Reinforcement consists of black, galvanized or barbed wire to suit maker, placed as near the outer portion of post as possible. The consistency of the concrete must be a quaking mixture.

"K" posts were among those suggested by the United States Department of Agriculture. They are triangular in form, each side being 6 in. wide, with all corners rounded and 7 ft. long. Reinforcement consists of three No. 8 wires, one in each corner of the post. Reinforcement is kept in place by a device called a fool-proof spacer. It consists of a No. 10 wire cut to such length that, when twisted once around each of two reinforcing wires, the ends will nearly touch the side of the mold.

The Board of Water Supply of the City of New York is perhaps one of the largest users of concrete fence posts in recent construction work, intending to use 61,070 concrete posts of various approved design to fence in the watersheds of the Catskill Aqueduct.

These posts are said to weigh from 110 to 120 lbs. each. No data is obtainable in regard to cost per post. The Department Engineer stated that two general designs were adopted, one reinforced and the other steel core; the former for most general use, the latter more especially for those rock locations where blasting might not be desirable, the base being shortened as necessary, the steel projecting into a shallow hole drilled in rock.

Conclusions.

(1) Concrete posts are practical, economical and a suitable substitute for wood.

(2) Reinforcement should be placed as near to surface of post as possible; ½ in. from surface is best location.

(3) Post should taper from base to top.

(4) Post should not be less than 5½ in. at base and 4 in. at top.

(5) Concrete mixture should consist of one part cement to four of run of pit gravel; or one part cement, two parts sand and four parts crushed rock or screened gravel. Gravel or crushed rock not to be smaller than ¼ in. in size, nor larger than ½ in. Concrete should be of a quaking consistency.

(6) Molds should have a jogger or vibratory motion while concrete is being introduced to compact it and smooth up surface of post.

(7) Posts should not be made out of doors in freezing weather. They should not be exposed to sun, and should be sprinkled with water the first eight or ten days after being made to aid curing.

(8) Molds should be carefully oiled or soaped to provide a smooth finish and to prevent concrete sticking to mold.

(9) Posts should be cured for not less than 90 days before being set or shipped.

(10) Posts should be carefully handled and be packed in straw, sawdust or other suitable material for shipment.

Recommendations.

(1) We recommend the adoption of Conclusions 1 to 10 relative to concrete fence posts.

(2) We recommend that the foregoing conclusions be substituted for those in the 1911 Manual of Recommended Practice, page 210, upon the subject of concrete fence posts.

(2) TRACK CONSTRUCTION AND FLANGEWAYS AT PAVED STREET CROSSINGS AND IN PAVED STREETS.

This subject has been under consideration for several years past, and your committee has studied the practice in European countries as well as our own. It would appear as if the street and interurban rail lines have reached a higher state of development in this respect, both at home and abroad, than the steam lines. It is but natural that it should have been so, because of the greater extent to which they have been confronted with the problem.

It is probable that the most advanced type of construction will suggest and determine that best design for steam road work. They have been in such intimate contact with the difficulties encountered in track construction in municipalities, where the requirements for street paving were very rigid, that they have now achieved a type of construction that is giving most satisfactory results for their kind of traffic. We submit below brief comments upon important features of such track construction.

Drainage.

The feature of good drainage, so essential to first class track construction, appears to have received abundant attention from street railway lines, and more than steam roads seem to have given it.

If the track superstructure is built on a concrete bed, the infiltration of water, which lies about the concrete, soon causes it to disintegrate under the constant impact of wheels passing over it, particularly at the rail joints, and soon reduces the concrete at such points to the consistency of mud, making track renewal soon necessary. If on the other hand ballast alone is used for the substructure of track, the natural bed beneath it soon becomes saturated and soft, and the resulting impairment of the track is inevitable. Drainage, therefore, is imperative. While satisfactory drainage provisions are necessary in any part of track construction, there is a conspicuous obligation to provide it at road, street crossings and through paved streets.

Each situation presents a separate problem, which will have to be solved to meet the conditions of the case; therefore, no definite recommendations can be made to cover the general proposition.

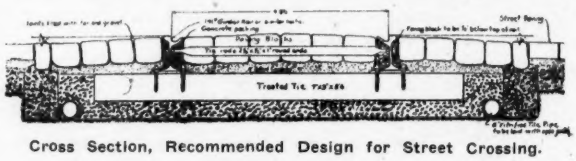
Paving.

In both this and foreign countries, asphalt, bitulithic, wood block, brick, granite and trap rock paving have been tried. It has been exceedingly difficult to keep the paving along the rails in good condition where asphalt, asphalt blocks or bitulithic was used. In most case where tried, these materials were removed from between the tracks, and for a distance of 2 ft. outside of rails, and replaced with wood or stone blocks. This has not only resulted in economy, but has also reduced the long interruptions to traffic due to the frequent repairs.

The substance of our investigations would seem to indicate that granite or trap rock specification blocks make the most suitable material for this purpose.

Substructure.

It seems from plans sent us, to have been accepted, that a concrete bed of thickness varying from 4 in. to 12 in. is the proper form of construction for the track substructure. Your committee, however, believes that this is not conclusive and that it is still open to question, particularly in the case of steam roads with extremely heavy cars and heavy axle loads of motive power, whether a concrete base will not have a train of evils to follow in its course, even more serious than those to be met with in using a foundation of hard



Cross Section, Recommended Design for Street Crossing.

rock ballast, or other suitable material, with proper drainage provisions. This view is supported by some prominent authorities, and actual experience.

It is to be observed that where ties rest directly on a concrete base, the bearing points at the joints are very rigid, causing the rail ends to hammer and soon become deformed. Water settling on the concrete bed at such points aggravates and hastens this condition. The adjacent rails themselves at a joint may vary by as much as 3-64 in. (the allowable limit), which is another condition that may lead to destruction of the rail and concrete beneath, from wheels pounding, where a certain amount of elasticity is absent. This state of affairs is readily noticeable in all street railway construction, regardless of how thorough the work was done originally. The service to be rendered by track under street railway traffic is not comparable to that needed under steam railway traffic. It is suggested that 60 ft. rails should be laid through road crossings and paved streets to reduce the number of joints, the weakest part of the track structure. The East Paris line in France uses rails 78½ ft. long.

It is doubtless true that there may be certain particular locations where the subgrade is of such an infirm character that a bed of concrete will have to be laid in order to properly support the track, but even in such cases a cushion of ballast should be interposed between the concrete and bottom of tie.

In a consideration of the various types of construction thus far tried, it is thought that the same design should be used at paved street crossings as through paved streets. The 141-lb., 9-in. girder rail appears to meet the general conditions of each case in the most satisfactory manner. It combines a proper form of flangeway for wheels, with the necessary flare to prevent horses catching the toe pieces of their shoes and holding them fast, together with the required depth for any character of paving. It will not permit of widening gage on curves, however. Ordinary tee rails (on chairs of various designs if necessary to obtain depth for paving), have been used; a special rolled form of flangeway or an old rail laid on its side for flangeway opening is frequently employed, usually the latter, but this cannot be considered as the best form of construction.

In previous committee reports upon the subject of the best form of flangeway, the idea of a special rolled filler to provide flangeway opening has been referred to. This feature has been given some study and we find two or three roads using such an arrangement. It is our opinion that such a form of flangeway is suited to road crossing construction where paving is not required, but is not well adapted to street crossings where rigid laws are in effect in regard to paving requirements, or through paved streets. The steel companies can roll these special forms, but they are very expensive because of the little tonnage that would be used. They are not mill stock, because a different section is needed for each weight of rail, and because of frequent changes in rail section. We present hereafter two outlines of these designs.

The 9-in. girder rail can be very readily compromised to the ordinary tee rail with which the track is generally laid on each side of the crossing or at the end of the paved street. It is not the intention of the committee to state that there are not other styles of con-

struction that will give, or do give, good results; nor is it of the opinion that a more permanent form will not be devised in the future, but it believes that for the amount of money expended, that the design submitted, already tried out under heavy service, will be best adapted to meet the most general requirements from the standpoint of durability, high standard and economy of maintenance. Simplicity of design and fewness of parts in any form of construction invariably leads to the achievement of the best results.

Conclusions.

(1) Specifications for best form of track construction and flangeways at paved street crossings and in paved streets:

Treated ties should be used, laid on a bed of crushed rock, gravel or other suitable material, not less than 8 in. nor more than 12 in. in depth, placed in about 3-in. layers, each to be thoroughly rammed to compact it.

Vitrified tile drains not less than 6 in. in diameter, with open joints, leading to nearest point from which efficient drainage may be obtained, or with sufficient outlets to reach sewers or drainage basins, should be laid on either side of and between tracks, parallel with ballast line and outside of ties.

One hundred and forty-one-pound 9-inch depth girder rail, or similar section, with suitable tie plates and screw spikes, should be used. Track should be filled in with crushed rock, gravel or other suitable material, allowing for 2-inch cushion of sand under finished pavement.

Ballast should be thoroughly rammed as it is installed for paving foundation to settle it. Two inches of good sharp sand should be placed on top of ballast.

Paving must conform with municipal requirements, granite or trap rock blocks preferred. Hot tar and gravel should be poured into joints as a binder.

(2) The inclusion in the Manual of the accompanying plan.

Recommendations.

We recommend the adoption of Conclusions 1 and 2, Specifications and Plan of Best Form of Track Construction and Flangeways at Paved Street Crossings and in Paved Streets.

(3) CONTINUE THE INVESTIGATION OF WAYS AND MEANS FOR SECURING A PROPER QUALITY OF FENCE WIRE TO RESIST CORROSION AND SECURE DURABILITY.

Your Committee has been continuing its investigations into this subject during the past year and has endeavored to obtain all available information as to the most recent practice, but it is compelled to state that the developments have been very few. It has investigated several foreign operations in the hope that they would indicate progress in the matter, but thus far these operations have not been applied to any large extent in the manufacture of fencing wire.

We believe that the method of weaving the wire is one of supreme importance and that the brutal treatment that the wire receives during the course of weaving at some plants might be responsible for the quick deterioration of the wire. So far no satisfactory method has been devised of galvanizing the fence fabric after it has been woven, although many attempts have been made, but the expense appears thus far to be practically prohibitive from a commercial standpoint.

It is often to doubt in our minds whether the asbestos process of wiping the wire is as productive of good results as that of the old form of charcoal wiping. The asbestos wipers cannot at all times be adjusted with care and accuracy, so that one strand may carry a fair coating, while another will be wiped so closely as to almost entirely denude the steel.

In our 1911 report we referred to a test that was being conducted by a certain railroad, commenced on April 1, 1909. We obtained an up-to-date report on this as of November 14, 1912, as follows:

Test A.—Galvanized after weaving: Is at this time found to be in perfect condition, with no indication of rust anywhere.

Test B.—Ordinary Dip Process: The corrosion in this fence has been rapid during the past year; the galvanized coating has entirely disappeared, and the entire section of fence covered by red rust, and the deterioration from corrosion very rapid.

Test C.—Special Galvanized: Found to be in excellent condition; no corrosion apparent.

Test D.—Sherardized: Shows corrosion in an advanced stage; the preventative of rust infusion has largely disappeared, and my conclusion is that this method of treating wire as a rust preventive has proven less satisfactory than any of the others. The advanced stage of corrosion in this fence is about the same as that of Test B. It may be said, however, that we have no means of knowing that our sample fence was sherardized in the best manner, as the best facilities for sherardizing could not be obtained at that time. It is possible therefore that more perfect sherardizing would give better results.

It must be said, however, in connection with Test D, that important developments have taken place during the past several years in this process, and it may be found by further research that it has considerable merit. We note by tabulated results of inspection of fence wire tests, Carnegie Technical Schools, Pittsburgh, Pa., fences erected in September, 1908, inspection made November 30, 1910, by Special Sub-Committee of Committee A-5, American Society for Testing Materials, that the sherardized woven wire fence, tabulated as Field No. 1, Inspection No. 27, showed an efficiency of 96 per cent, standing very closely in merit to the unwiped wires and wire galvanized after weaving, which were at that time practically perfect. It is unfortunate that these tests at the Carnegie Technical School had to be discontinued, as we learn that the fences were removed or at least disarranged through the extension of the plant at that school.

Your Committee is not prepared at this time to offer any additional information on this subject, nor is it warranted in reaching any conclusions. It believes that it is incumbent upon the railroad companies, in the light of past experience and with the information that has been imparted from time to time by the Association, to pursue their own investigations, and that investigation of this subject by the Association should for the present be discontinued.

Recommendations.

(1) We recommend to the Board of Direction the discontinuance for the present of the instructions to investigate ways and means for securing a proper quality of fence wire to resist corrosion and secure durability.

(2) We recommend to the Board of Direction that they assign to the Committee the investigation of the various kinds of signs for railroad purposes as applicable to both employe and the public.

Discussion.

R. L. Humphrey (Consulting Engineer): I think we should specify in Conclusion (5) "gravel or crushed rock of low absorption."

This suggestion was accepted by the Committee.

S. G. Jordan (B. & O. R. R.): Why does the Committee specify that concrete posts must be cured not less than 90 days?

C. H. Stein (C. R. R. of N. J.): It is the opinion of all manufacturers that at least 60 days should be allowed, and 90 days is better. The post should be as strong as possible, as it has to be shipped, unlike most other concrete. Our experience shows that all concrete continues to gain in strength even after 90 days. We specify 90 days to be on the safe side. Users who desire may limit the time to 60 days.

R. L. Humphrey (Consulting Engineer): Steam seasoning can be used to accelerate curing. Some manufacturers are curing by steam, so I think Conclusion (9) should read, "cured 90 days when cured naturally."

The Committee accepted the suggested change.

E. V. Smith (B. & O. R. R.): I do not think the Committee should specify in the first paragraph "a maximum depth of not more than 12 inches."

C. H. Stein (C. R. R. of N. J.): This recommendation is the result of experiences of roads which have tried it. A greater depth causes more surfacing on account of compacting of the ballast, than a shallower depth if there is good supporting ground.

F. P. Patenall (B. & O. R. R.): I think the note specifying "concrete packing" should be eliminated and "as specified" substituted.

C. H. Stein (C. R. R. of N. J.): The Committee will substitute "form of packing."

Robert Ferriday (C., C., C. & St. L. Ry.): It seems unnecessary and contrary to what we know of ballast to specify a maximum in this case of 12 inches. Our Ballast Committee says an increase to 18 or 24 inches decreases maintenance. I move "not more than 12 inches" be eliminated.

The Committee accepted that suggestion, and the report was accepted.

MASONRY.

G. H. Tinker, *Chairman*; F. L. Thompson, *Vice-Chairman*.

The work assigned to the Masonry Committee by the Board of Directors was as follows:

(1) Report on waterproofing of masonry and bridge floors, including methods, cost and results, with definite recommendations.

(2) Report on the effect of concrete structures of rusting of the reinforcing material.

(3) Report on the principles of design of plain and reinforced concrete retaining walls, abutments and trestles.

The following Committees were appointed on this work:

(A) To consider report on waterproofing, etc., as given in Item 1: F. E. Schall, Chairman; C. W. Boynton, J. K. Conner, L. D. Crear, L. N. Edwards, Philip Petri and J. J. Yates.

(B) To consider report on Item 2: C. W. Boynton, Chairman; Robert Armour, A. H. Griffith, G. W. Hegel, Richard L. Humphrey, W. H. Petersen and G. H. Scribner, Jr.

(C) To consider report on Item 3: L. J. Hotchkiss, Chairman; F. L. Thompson, G. J. Bell, T. L. Condron, J. H. Prior, A. N. Talbot and Job Tuthill.

In the spring it was necessary for the Chairman, Mr. Tinker, to relinquish the Chairmanship of the Committee temporarily and during this time the work was handled by the Vice-Chairman.

A number of Committee meetings were held by Sub-Committee A in connection with waterproofing, and as the subject is a large one, in which materials and new methods are coming into use all the time, it

has been found impossible to submit a satisfactory report for printing in the proceedings at this time.

Sub-Committee B has held a number of meetings in regard to the effect on concrete structures of rusting of the reinforcing material, and a report of this Sub-Committee is attached hereto as Appendix A.

Sub-Committee C has done a great deal of work during the summer and fall on the principles of design of plain and reinforced concrete walls, abutments and trestles.

The Chairman of this Sub-Committee resigned and Mr. T. L. Condron consented to serve as Chairman of the Committee.

They have done a great deal of work in the way of investigation and gathering together the information as to the design of retaining walls, abutments and trestles. They also made some effort to get some money from the Board of Direction and individual subscriptions in order to make a test of a section of a large size retaining wall, but were unable to obtain the necessary money to make this test. It is hoped the Board of Direction will see their way clear to authorize this test this coming year. Other than this the Committee has no report to make this year.

JOINT COMMITTEE ON CONCRETE AND REINFORCED CONCRETE.

During 1912 the Joint Committee has revised its previous report, to which has been added some new matter and the whole brought up to date. The report will be available to the various societies represented, including the American Railway Engineering Association, in

G. H. Tinker, Chairman Committee on Masonry.

the near future. The American Society of Civil Engineers received and accepted this report on January 15, and continued the Committee.

JOINT COMMITTEE ON STANDARD SPECIFICATIONS FOR CEMENT.

During the year meetings of the Joint Committee on Standard Specifications for Cement were held in an effort to harmonize the differences between the American Society for Testing Materials and the Government Engineers, and acting upon a resolution, representatives from the American Society of Civil Engineers, the United States Government, and the Society for Testing Materials were requested to confer relative to these differences. This conference had its initial meeting October 24, 1912, organized, and has been carrying on such investigation work as may lead to an agreement on Uniform Methods of Tests and Standard Specifications for Cement.

APPENDIX A.

Disintegration of Concrete and Corrosion of Reinforcing Metal.

Attention should be directed, in cases where disintegration of concrete and corrosion of reinforcing metal are under investigation, to the quality of the concrete, to the concrete materials, and to the workmanship before any conclusion can be drawn as to the effect upon good concrete of the deteriorating agencies present. In deciding upon preventive measures again due attention to materials and workmanship will usually prove to be the most effective.

The failures of concrete structures most commonly reported are those due to (1) faulty design, including details; (2) use of improper materials; (3) poor workmanship; (4) neglect of proper precautions in removing forms and applying loads and otherwise overstressing new concrete structures.

While the subject of failures due to these causes is not considered to be included under the Committee's assignment, they are sometimes wrongly supposed to be due to the disintegration of concrete.

Failure to properly provide for shrinkage of concrete due to hardening in air, and for expansion and contraction due to temperature changes, is a common cause of cracks which may lead to failures.

The requirements for good materials have been described in numerous texts, specifications and reports, together with the methods of determining whether or not the materials meet the requirements. However, the proper precautions are not usually observed in choosing materials, especially aggregates. Although good concrete can be made with crushed stone screenings as fine aggregate, the results of laboratory tests on this material are likely to be misleading, and tests on specimens made to reproduce as nearly as possible field conditions of mixing, placing and hardening are especially desirable when screenings are used.

To obtain good work, competent and ample supervision is necessary, and no expedient can be resorted to that lessens the requirements for workmanship. In practically all cases where failures have been investigated, it has been found that the workmanship could have been improved with profit.

Probably the most common cause of failures of concrete structures has been the premature removal of forms. It has been definitely established that low temperature retards the hardening of concrete, and in work done during cold weather precautions should be taken accordingly.

Concrete in Sea Water.

Investigations concerning the effect of sea water on concrete immersed for periods up to fifty years or more; of the relative merits of standard Portland cement and Portland cement made with varying contents of SO_3, MgO, CaO, Fe_2O_3, Al_2O_3, SiO_2, etc., in resisting the disintegrating effect of sea water; of the effect of varying the proportions of cement in the mortar and concrete; of the addition of various finely ground materials to the cement after burning; of the relative durability of concrete cast in place as compared with concrete blocks allowed to harden before placing in the sea; and of the effect of various materials added to the concrete mixture to produce impermeability and consequent increased durability have been made in various European countries and in America.

Regarding the chemical composition of the cement, the following conclusions are presented:

Cement containing up to 2½ per cent of SO_3 resists the action of sea water fully as well as cement with lower SO_3 content.

While all the hydraulic cements now in use are liable to decomposition in sea water, Portland cement is the one to be preferred in every respect.

High iron Portland cement and puzzolan cement have failed to show superiority over Standard Portland cement in resisting the disintegrating effect of sea water.

Regarding the effect of varying the proportions of cement in the mortar and concrete, in general the richer mixtures have been found to offer better resistance to the attack of sea water. Proportions recommended for mortars are those with one part cement to one part of sand up to one part cement up to two parts sand. The bad condition of mortars leaner than the above after exposure in sea water stands out prominently. In the use of reinforced concrete for maritime works, it is advisable to employ larger proportions of cement than are usual for similar works in fresh water.

Regarding the use of any material added to the concrete mixture in small quantities in order to reduce permeability, no results of practical working tests have demonstrated the value of any material in reducing permeability.

Concerning the addition of finely ground material to the cement after burning, it has been found that the addition of ground puzzolan or furnace slag to Portland cement increases the resistance of the resulting mortar or concrete to the disintegrating effect of sea water.

Allowing the concrete to harden under favorable conditions before exposure to the action of sea water greatly increases its resistance to attack by the sea water and is recommended wherever possible.

When concrete is deposited under sea water such precautions should be observed as will prevent the washing of the cement from the mixture. Forms should be so tight as to prevent the entrance of sea water after depositing the concrete in order that a smooth surface may be obtained sufficiently rich in cement to be impermeable after properly hardening, and with the forms removed.

Where the effect of sea water on concrete has been other than mechanical, it is believed that disintegration is caused by the substitution of MgO from the sea water in the place of the CaO of the cement, as well as to the decrease in the proportion of silica and the increase in SO_3.

The making of a dense, impermeable concrete by the use of a well-graded aggregate, rich mixture, proper consistency, and good workmanship, and allowing the concrete to harden under favorable conditions before being exposed to the action of sea water, are generally conceded to be efficient means of satisfactorily insuring the preservation of concrete in maritime works.

Concrete Subjected to the Action of Water Containing Acids or Alkalies.

Investigations concerning the effect of ground waters, which contain acids or alkalies, on concrete drain tile, sewers, tunnel linings, etc., and of the effect of sewage on concrete used in sewers and disposal works, have disclosed several instances of apparent disintegration. The following points have been demonstrated in regard to the resistance of concrete to these agencies:

Drain tile which, due to the use of poor aggregates, improper methods of manufacture or the use of lean mixtures, are porous may be affected by the soil acids found in some localities or when required to carry strong alkali seepage common in many irrigated sections of the western United States.

The aggregate should be composed of materials inert to the acids or alkalies present in the water. A chemical examination of the sand from country known to contain alkaline soils is to be recommended.

Water containing substances known to react with the elements of the cement should be kept from coming in contact with concrete until the latter has thoroughly hardened.

Care should be taken to provide a smooth surface and sufficient slope in the extrados of the arch of tunnel linings and sewers when the ground water level lies below the tunnel grade to facilitate the flow of seepage water to the sides. It is believed that the back filling over the arch ring should consist of porous material such as coarse, crushed stone, for the same reason. It is also believed that side drains should be provided where necessary and connected with an under-drain, which should be provided in all cases.

The alkalies which are most active in causing disintegration of concrete when allowed to penetrate into the interior of the mass are the sulphates of sodium, magnesium, and calcium.

The measures to be used in making concrete which is to be exposed to the action of these deteriorating agencies in order to prevent disintegration are the same as recommended for sea water construction. Impermeability is the prime requisite and the results of experiments and practical tests indicate that plain concrete, carefully prepared, is just as resistant, if not more so, than concrete mixed with foreign materials or special preparations.

Disintegration of concrete in sewers and sewage disposal works, whether due to the use of poor materials, poor workmanship, or insufficiently rich mixtures, has been found to take place above the normal surface of the liquid contained. The following explanation is advanced for this action:

Quantities of hydrogen sulfid are evolved from the sewage. This sulfid is produced in two ways: (a) By the bacterial decomposition of sulphur-containing-proteins and related compounds, and (b) the reduction of sulphates which are contained in unusual amounts in some water supplies. Of the two, the second seems to be the more important. The hydrogen sulfid which escapes as gas from the sewage is partially dissolved in the moisture on the under side of the roof and concrete walls. Here it is oxidized to sulphuric acid, partly by atmospheric oxidation and partly by bacterial action. The sulphuric acid acts upon the calcium compounds in the concrete-forming calcium sulphate and breaking down the concrete.

Disintegration of Cinder Concrete.

Cinders with much sulphur are likely to give unsatisfactory results in concrete, especially if there is much coke or porous material present. Such cinders may be improved if allowed to weather, with occasional washing, until the ferrous iron and sulphur have been oxidized and bleached out.

Porous cinder concrete in roofing slabs exposed to the action of locomotive gases does not form an efficient protection for reinforcing metal, which has been found to corrode and cause the disintegration of the slab.

Freshly made concrete surfaces in contact with smoke gases at temperatures below 45 degrees F. have failed to harden properly, and experiments indicate that under such conditions the cement is acted upon by some of the gases. It has therefore been recommended that when heating is done by means of open fires, higher temperatures should be maintained.

Effect of Electric Currents.

Laboratory experiments furnish most of the information which exists concerning the effect of electrical currents on concrete and reinforcing metal. The discrepancy between the conditions in these experiments and field conditions seems to be greater than is the case in other laboratory tests on structural materials, and the information obtained up to this time is difficult of application to field conditions.

It has not been shown that the strength of plain concrete is affected by the passage of an electric current through it.

It is generally accepted that if an electric current passes into concrete through steel which is tightly embedded in it the steel is corroded and the expansion of the metal, due to corrosion, disrupts the concrete. Corrosion takes place at the anode (pole from which current flows). The cathode is not affected by oxidation.

Corrosion of Reinforcing Metal.

Results of experience up to date have shown no reason for changing the conclusions presented in the Progress Report of the Joint Committee on Concrete and Reinforced Concrete, 1908: "Tests and experience have proved that steel embedded in good concrete will not corrode, no matter whether located above or below fresh or sea water level. If the concrete is porous, so as to be readily permeable to water, the metal may be corroded in the presence of moisture."

Discussion.

F. L. Thompson (I. C. R. R.): The Committee's work has been handicapped by the illness of G. H. Tinker, Chairman. The report is in good condition but not ready for publication. We desire to withdraw Appendix A, as it was printed without the consent of the Committee.

YARDS AND TERMINALS.

C. H. Spencer, *Chairman;* E. B. Temple, *Vice-Chairman;* W. G. Arn, Hadley Baldwin, W. C. Barrett, G. H. Burgess, A. E. Clift, H. T. Douglas, Jr., A. C. Everham, Geo. P. Johnson, D. B. Johnston, H. A. Lane, L. J. McIntyre, B. H. Mann, A. Montzheimer, W. L. Seddon, E. E. R. Tratman, W. L. Webb, J. G. Wishart.

The Board of Direction assigned the following subjects to your Committee:

(1) Report on typical situation plans of passenger stations, of both through and stub types, with critical analysis of working capacity, and include a review of the different methods of estimating their capacity.

(2) Report on developments in the handling of freight by mechanical means.

(3) Report on developments in the design and operation of hump yards.

Various meetings of Sub-Committees have been held during the year, and a meeting of the entire Committee was held in Pittsburgh, September 27 and 28.

(1) TYPICAL SITUATION PLANS OF PASSENGER STATIONS.

(1) In the development of the subject the Committee presents, in Appendix A, situation plans and description of the business handled at passenger stations: Baltimore, B. & O. R. R.; Baltimore, Penn. R. R.; Boston, South Station; Philadelphia, B. & O. R. R.; St. Louis, Union Station; Washington, Union Station.

(2) In arriving at a description of the business handled at each station the following outline has been used: (1) Handling of mail; (2) handling of express; (3) handling of baggage—(a) individual, (b) theatrical; (4) passengers—(a) through, (b) local, (c) suburban.

Each item should be considered apart from any other, particularly as to that which fixes the maximum capacity in a certain unit of time, say, one hour. This would be followed by consideration as to whether this speed or maximum capacity could be sustained for a longer period. Finally the four headings would be considered as applied to each layout.

(3) The Committee offers three methods of graphical critical analysis of working capacity of throat and station tracks at a station.

The first method has been used by the Belgian State Ry. and is shown in an article by Messrs. Weissenbruch and Verdeyen in Bulletin of International Railway Congress, Vol. XXII, No. 9, September, 1908.

The second method has been used by the Pennsylvania R. R. in studies of the Broad Street (Philadelphia) Station.

The third method has been designed for the Committee work this year.

A method devised for the Dirschau Passenger Station and described in Bulletin of International Railway Congress, Vol. XXIII, No. 2, February, 1909, is, after consideration, not recommended.

The essentials to be shown on diagram for analysis of working capacity of a passenger station are:

(1) Occupation of station tracks—(a) Capacity of each track; (b) time of occupation; (c) make-up of trains; (d) movements, if any, on internal crossovers in station; (e) number of trains and route arriving and departing and direction of movement.

(2) Movements on throat tracks—(a) Arbitrary time over route; (b) whether scheduled trains, drafts, road engines or switch engines; (c) route used before entering and after leaving, and direction of movements; (d) interference from cross movements.

Each of the three methods submitted has stood the test of application to extremely heavy traffic conditions.

DIAGRAM OF TRAIN MOVEMENTS AT CAMDEN STATION, BALTIMORE, MD., USING BELGIAN DIAGRAM.

The diagram showing train movements at Camden Station, B. & O. R. R., is an application of the diagram which is in use on the Belgian State Railways, and was worked out by officers of that system.

In applying this diagram to Camden Station there were certain minor features added to those given in the above Bulletin, especially the table showing the capacity of tracks and the symbols used to designate the number and kind of cars occupying the platform tracks. This was for the purpose of showing whether or not two trains could occupy the platform track at the same time.

In the diagram of Camden Station two hours were selected in which the number of movements was at a maximum. Many of these movements were switching movements, and during the particular time chosen the station platforms were not utilized to their full capacity for inbound and outbound main line trains. This period was selected and the diagram prepared to show especially the possibility of representing internal switching movements as well as the movements of trains and light road and switching engines.

The diagram as applied to Camden Station shows its use for both a terminal station and a through station, since tracks 1 to 7 inclusive are stub tracks in the train shed, while tracks 8 and 9 are on a lower level, entering the Belt Line Tunnel on the main line between Philadelphia and Washington, constituting a through station.

The fundamental idea of the Belgian diagram is to select a certain number of platform tracks, access to which is secured over one track, or a short stretch of a track, which can be called the "running line" of the group selected.

In order to represent routes and to immediately detect movements which would foul each other, numbers are selected to indicate the different routes.

The value of the diagram depends entirely upon the selection of the running lines and the numbers representing routes. The route numbers and the station platform numbers can be made different in design, and running lines should be shown in dotted and broken lines or in lines of different colors. There may be several selections of running lines and routes, but after one or two trials the arrangement that gives the greatest station capacity will be easily determined.

Vertically the diagram is divided into minutes, and covers the period from 5:30 p. m. to 7:30 p. m. The horizontal lines represent platform tracks and running lines. The numbering of routes and internal fouling points shows at a glance along any vertical line whether there is a confliction of movement. Reading from the top down, the numbers representing the routes must increase in size, or it means that the movements conflict, because they take place on the same route or fouling point at the same minute. The number of the train is written below the line representing its movement. Arrows pointing to the left are movements out of the station or towards the west. Arrows pointing to the right are movements into the station or towards the east. The time which is consumed by any movement on the running line is represented by the length of the movement line drawn on the running line. These movement lines are all shown very much heavier than the lines representing station tracks or running lines. The close movements on the north running line shown on the diagram as taking place at about 6:47 could not be allowed if the movement were main line train movements. As they are all switching and light engine movements, it is permissible to run them as closely as shown during those few minutes.

The switches in this layout are all controlled from the tower, but the interlocking arrangements do not require an entire route to be set up and maintained until the movement has cleared the whole block.

This diagram covers the five essentials which have been submitted by the Committee as necessary for a graphical analysis of working capacity of a passenger station in regard to the occupation of station tracks. By the table at the right-hand side of the diagram the capacity of each track may be ascertained. It shows the composition of the train or cut of cars occupying the track and the length of time that the different trains or cuts occupy that track, and whether there are cars taken off or added to those on the track. It shows internal movement, also the number and route of arriving and departing trains with their direction. As applied to the movement through throat tracks or fouling points, the numbers are placed at these fouling points and show the route, the arrows the direction of movements, and the symbols as noted in the legend the class of movements, such as trains, light road or switching engines, or switching engines with a cut of cars. The time that is taken by a movement on any track is shown by the length of the heavy movement line as drawn on the line representing that track on which the movement is taking place.

DIAGRAMMATICAL METHOD OF SHOWING ACTUAL OCCUPATION AND WORKING CAPACITY OF STATION AND THROAT TRACKS, BROAD STREET STATION, PHILADELPHIA, PENNSYLVANIA RAILROAD.

For a number of years past it has been apparent that the track layout of station and approaches at Broad Street Station, Philadelphia, is seriously congested by the train movements incident to handling the service of that terminal.

The need for additional relief led to the appointment about two years ago of a Board of Engineers to study the whole situation, and prepare plans and submit a report for additional facilities. The Board in their report gave careful consideration to the adoption of electric traction for the suburban service terminating at Broad Street Station, with the result that a Transportation Committee, composed of operating men, was appointed to consider with the Board of Engineers the possibilities of an electrified suburban service, particularly as to the relief that would be afforded in the operation of the train service at Broad Street Station.

An analysis of the station and throat track layout develops the fact that there are six route or throat tracks at Eighteenth street connecting the eight elevated approach tracks to the sixteen station tracks, over which all passenger train movements are made.

It was apparent from these facts that with the proper data at hand, graphical charts could be prepared that would show all movements actually made over the throat tracks, including blockade of routes, and would indicate the extent to which these facilities were used. This method was therefore adopted and the necessary data obtained in the following manner: Four men were stationed at "A" cabin from 8 to 10 a. m. and from 4 to 6 p. m. on a certain day, two of whom were assigned to recording the inbound and two to the outbound movements. Each man also recorded in each case the character of train unit, the number of cars, engine numbers, etc., as well as the actual time to the nearest quarter minute of the setting up and clearing of the route in question, as these facts were noted by the second man, who was thoroughly familiar with the interlocking.

In preparing the throat track charts, the six routes were plotted as adjacent parallel spaces of convenient width and length, on which time was indicated by perpendicular lines. Each individual movement made over the different routes was plotted as a solid line rectangle, cross-hatched with solid lines to show direction of movement and covering the time included between the actual setting up of the route and its clearance by the movement in question. The blocking of routes other than the one actually in use by any given movement was shown by rectangles, cross-hatched with dotted lines. The character of each train unit handled was indicated on the charts, and, where blockades of other routes resulted, the actual movement made was shown.

Similar diagrams were also prepared from the above mentioned data, showing, respectively, the occupancy of station tracks, and the movements made on the eight elevated passenger tracks between the interlockings at "A" and "B" cabins, but these latter diagrams are not here submitted.

Examination of these diagrams or charts indicates very clearly the congestion now existing, and shows conclusively that the tightest place is at the throat of the station, and that the six routes in their capacity for handling movements are not evenly balanced. This condition is due to the character of the track layout, whereby routes D, M and A on the south side of the terminal, collectively reaching all station tracks, must be used exclusively by movements to and from tracks Nos. 1 to 13, inclusive, while routes U, X and Y reach and serve only tracks Nos. 14 to 16, inclusive, the result being that routes D, M and A are taxed beyond their capacity.

These different charts are well adapted to the study of the results to be obtained from electrification; the elimination of shifting movements that would follow the use of multiple-unit electric traction for certain groups of trains being readily indicated on the original diagrams.

The replotting of trains can be done without introducing unknown factors, as it is only necessary to adhere to the figures obtained in actual practice, as given in the tower records and plotted on the original diagrams. If new trains are to be introduced, a glance at the station chart will show what platforms are available at any particular time, and, by referring to the throat track chart, one can easily ascertain whether the movement can be made at the desired time without interference with existing conditions.

GRAPHICAL DIAGRAM DEVISED BY COMMITTEE FOR USE IN ANALYZING WORKING CAPACITY OF PASSENGER STATIONS.

Purpose.

The purpose of the graphical diagram showing working capacity of passenger station is twofold: (1) To make clear the necessity for changes in the design in the way of revision of or additions to the track layout. (2) To lay out a working time card.

Requisites as to Station Tracks.

It is desirable to be able at a glance for each station track to see relatively for any instant: (a) The capacity and the space yet available. (b) The make-up and amount of equipment occupying. (c) The scheduled time of arrival and departure of such equipment. (d) The switching movements required on any connecting internal crossover. (e) The route arriving and departing, and the direction of the movement.

Requisites as to Throat Tracks.

The diagram should show clearly: (1) What throat tracks directly serve the various station tracks without interference with other routes; also similar information as between the throat tracks and the different main or running tracks outside of the station. (2) The arbitrary time consumed by a movement over a throat track from the time the route is set up until it is cleared. (3) Whether the movement is a scheduled train, draft road engine or a switch engine. (4) The route used before a movement enters a throat track and after it leaves. (5) The direction of the movement. (6) Any interference from cross movements.

The method of graphical analysis designed for the Committee contemplates satisfying each of these requisites. It has been applied on the attached diagram to the Broad Street (Philadelphia) Station, for

which data was available covering the approximately one hundred and fifty (150) movements that are regularly made in the two-hour interval, 8 a. m. to 10 a. m. Such heavily congested traffic was selected so as to thoroughly test the method.

On the diagram heavy lines plotted as co-ordinates represent, respectively, the abscissa or horizontal line the station track, the ordinate or vertical line the throat track, and a second abscissa the main running track. A line is provided for each unit in these three classes of tracks. A scale representing hours and minutes is plotted on each of these lines. For clearness no less than one-twentieth of an inch should be allowed for each minute.

Information as to Station Tracks.

The capacity of each station track may be shown by a number placed against the station track line to show its length in cars. Each station track line is also marked to show the number of track which it represents. The amount of space available on any track at any instant is the difference between the number of cars shown in any movement or movements occupying the track, and the total capacity of the track. Each occupying movement is shown by a relatively thin line paralleling and alongside of the station track line, and marked as to the character and make-up, both in cars and engines. The time of arrival and departure of any movement is shown by the minute on the scale at which the movement line, now extending vertically, crosses the track line. The heavy horizontal scale lines representing the station tracks jointly served by any certain throat tracks are assembled in a parallel group. The switching movements required on any internal crossover connecting with station track may be shown by drawing thin movement lines from the proper point, as to scale, on the occupation line on one track, through the proper point on the scale of the track to which the crossover connects, paralleling the latter during the time of occupation, and returning vertically again to the original occupation line on the first track. The route arriving and departing for any movement is shown in order by the figures and letters plotted on each movement line near the point of origin or ending on the station tracks, and denotes the respective station tracks, throat tracks and running tracks occupied. The direction of the movement is shown by an arrow.

Information as to Throat Tracks.

The relative position of the vertical lines representing the throat tracks, and the horizontal lines, representing respectively the station tracks and the running tracks, show the grouping as to direct connection one with the other. The arbitrary time consumed by a movement over a throat track from the time the route is set up until it is cleared is measured by the minimum space allowed between the crossing movement lines on the vertical scale line representing the throat tracks, and may also be shown by a number representing the minutes and placed at one end of the throat track line. The scales used should be no less than one-twentieth of an inch to the minute for clearance sake. The vertical lines representing the throat tracks are respectively marked with the letters used to designate each throat track. The conventional movement lines, in addition to being designated at the points of origin and ending by figures and letters denoting as to whether they are trains, drafts, road engines or switch engines, and also as to the route used before a movement enters a throat track and after it leaves, may also be distinguished as to classification of movement by the use of different colors, just as is customary in the use of strings or lines denoting on an ordinary railroad district time-card chart somewhat similar classification. The direction of a movement is given by the arrows at the points of origin and ending, and the interference of a movement on any throat track is shown by the fact that the movement line passes across each and every throat track line that may be blocked by the movement.

Whereas on the station tracks the interval of time occupied is measured by the distance between the points of crossing of the movement entrance and exit lines over the station track scale lines; on the other hand, on the throat track the movement line crosses the scale at a point in the middle of the arbitrary time during which the route is blocked by the movement.

In General.

The Committee recommends that for the design of a large passenger terminal there should be considered the situation plans submitted to the Association in 1911, and shown in inserts opposite page 240, Vol. XII, Part 1, of Proceedings, eliminating the notation 1-7 as applied to angle of ladder. These layouts would be expanded or multiplied in such a way as to best meet the requirements of the real estate owned at any particular location.

The Committee also desires to emphasize the possibility of the substitution of inclines or ramps in place of stairways in busy stations. In all such stations where track level is above or below street level, stairway connections have the objection of interrupting and checking the flow of travel at busy hours. This is especially the case where much suburban traffic is handled.

It is of interest to note, therefore, that in the new Grand Central terminal at New York inclines have been adopted at several points, presumably because they were considered safer and more expeditious than stairways. The grade of these inclines seems to be 8 per cent. Experiments have been made to determine the grade best adapted for convenience. In many places there is not space available for such inclines, but in designing new stations this feature might well be studied.

In the design of a large passenger terminal the Committee presents for adoption the following conclusions:

(1) A holding yard should be directly connected with platform tracks to provide for a quick emptying and refilling of the latter.

(2) At passenger terminals, where large quantities of baggage and express must be handled, and it does not appear expedient to provide intermediate platforms to be used exclusively for this service, it is recommended that, where conditions permit, baggage and express be received, delivered and handled below or above the train floor (as grade conditions demand) and raised and lowered by elevators, conveniently located, to avoid interference with the movement of passengers.

Note.—Conclusion of 1911 amended by providing for handling baggage and express above as well as below train floor and inserting "as grade conditions demand."

(3) To provide for proper coupling of cars a maximum curvature for storage and loading tracks of 6 degrees is recommended.

(4) For safe, efficient and economical operation on station throat tracks the curvature through switches should not exceed that of a No. 8 slip on tangent.

The Committee presents as a progress report, without recommendation as to relative merits, the three methods of graphical analysis of working capacity of a passenger station.

Should it be desired to handle a new train with four cars at the terminal, the time of arrival having been given by the management as 9:35 a. m., and the division delivery such as to make the use of running track No. 7 practicable, it will be noted on the diagram that there is clear space at that time on running track No. 7 and on throat track "X" and available room on station track 15, and instructions that the movement will be so handled may at once be given. Traffic conditions also show that this is about the only place in the station at that time where this movement could be handled without probable delay.

Should it be desired at any terminal to use this method in laying out a working time card, chart boards of a size sufficiently large to suit the purpose will be provided, on which will be permanently plotted the scale line conventions for the station tracks, throat tracks and running tracks. The movements would be indicated temporarily by lines of different colors and would be shown upon the chart by means of strings fastened by pins, as is done on the ordinary railroad district time chart. Tags properly marked and attached to the pins at the originating and terminating point of the movement would give the detail information required, so that after the movements are plotted to meet requirements of the proposed new time card, the information could be checked and called off in the customary way for making up the printed working list, showing arrival and departure of trains and tracks used for each.

Should certain movements during any interval of time appear to create an undesirable congestion of traffic, a rearrangement of the strings on the chart may be studied and put into effect, and the possible interference brought about by any such change anticipated and avoided.

Should one or more station tracks appear to be handling more than their share of the traffic, similar attention to the chart or diagram can be given, and if no other solution develops the necessary slight changes in track connections may be made.

Where congested traffic demands, the working charts or diagrams need only be limited in size by the space on the wall available and within reach, and, as a rule, where the traffic is as congested as in the Broad Street Station, extra sets of charts may be required to satisfactorily cover the day's work. One possible good feature of this method is that it may be handled personally by transportation men, making use of the colored strings, and may be revised and rearranged by them quickly to suit any change in traffic conditions.

The make-up of the trains may, if desired, be shown on the diagram also by conventions, representing arbitrarily each style of equipment, placed in order on a line at right angles with each station track scale line and against the time of arrival or departure, indicating the mail, express, baggage, coaches, dining cars, sleeping cars and parlor cars.

DESIGN AND OPERATION OF HUMP YARDS.

The Centralia yard will be put in operation about December 1, 1912. On this account it will be impossible to give any detailed results of the actual operation of the yard in this report. The mechanical plant at the Centralia yard will not be completed until the spring of 1913.

The yard, as constructed, has but one hump, and this will be used for classifying northbound freight only. Provision has been made, however, for the construction of a second hump for classifying southbound business, should it be required. The main tracks are separated and yard located in the center, so there will be no traffic crossing over mail tracks. Southbound main is located twenty feet from yard tracks.

The grades on the hump are less than in yards constructed several years ago, and were adopted after making a careful study of

other hump yards, it having been found in actual practice that in some cases grades were too steep, which caused damage to cars and necessitated more riders.

Conclusions.

Recommendation No. 1.

Where tracks are set aside for holding empty cars, the grade leading to such empty tracks should be increased so that empty cars will move with the same velocity as loaded cars switched to adjoining tracks.

Recommendation No. 2.

The Committee has investigated the "Cut List" system of handling cars on the hump and recommends it as being safe and efficient. This system is briefly described as follows:

The yard clerk makes up a list of cars to be switched and tracks they are to be placed on in receiving yard, cut No. 1 being the first car to go over the hump.

Cut list form accompanies this report. It is perforated on three vertical lines, so the list may be divided up into four parts, each part being a duplicate of the other.

Where switches are thrown from a tower, one copy of the list is given to the towerman and one to the man cutting off cars on the hump. Where switches are thrown by hand, each switch tender has a copy of the cut list as well as the man cutting off cars on the hump.

DEVELOPMENT IN THE HANDLING OF FREIGHT BY MECHANICAL MEANS.

During the past year the Committee has made considerable study of the mechanical handling of freight, especially as to the work carried on at the freight house of the Missouri, Kansas & Texas Railroad at St. Louis; the Baltimore & Ohio Railroad, Pier No. 8, Locust Point, Baltimore, Md.; the Wabash Pittsburgh Terminal Railroad freight house at Pittsburgh, Pa. It has also made further study of the use of electric trucks and other appliances.

(The report on these subjects was submitted as information.)

Discussion.

Wm. McNab (G. T. Ry.): It seems to me the wording of the recommendations would be better if changed to "It is recommended that, where advisable, baggage and express be received, delivered and handled below or above the train floor," etc.

C. E. Lindsay (N. Y. C. & H. R. R. R.): I move the omission of the word "safe" in Conclusion (4).

C. H. Spencer (Wash. Term. Co.): The Committee objects to eliminating "safe." The time is coming when this Association will have to entertain this question, and recommend that which is safe as well as efficient.

L. C. Fritch (C. G. W. R. R.): I think the use of the word "safe" is unfortunate here. It would cost a good deal of money to replace short turnouts which are answering the purpose all right.

C. E. Lindsay (N. Y. C. & H. R. R. R.): A road may be entirely justified in adopting No. 8 crossovers. We use 6½ frogs in the Grand Central Terminal, and think they are perfectly safe for the equipment and operating conditions. At one time we had a lot of derailments on No. 7 frogs with a certain class of engine. We took up the matter with the Mechanical Department and changed the design of the locomotive. This eliminated our trouble.

J. L. Campbell (E. P. & S. W. Ry.): I move the reading be changed to "where practicable on station throat tracks the curvature through switches should not exceed that of a No. 8 slip on tangent."

The Committee accepts that.

The Chairman submitted a slightly modified reading for Conclusion (2), Hump Yards.

A discussion followed, stating advantages of the "cut list" system; the reading was again changed, eliminating "safe," as it was held "efficient" included safety.

The conclusions were adopted.

W. I. Trench (B. & O. R. R.): I think the car rider should be given the number of cars in each cut by chalking this information on the end of the head car in each cut, and the track consigned to.

C. H. Spencer (Wash. Term. Co.): There is no limit to the ways in which the cut list can be extended, and we have provided for a multiple cut list in the recommendation.

C. C. Churchill (N. & W. Ry.): This Committee has presented a very valuable report and is dismissed with the thanks of the Association.

ELECTRICITY.

George W. Kittredge, *Chairman;* J. B. Austin, Jr., *Vice-Chairman;* D. J. Brumley, R. D. Coombs, A. O. Cunningham, L. C. Fritch, Geo. Gibbs, G. A. Harwood, E. B. Katte, C. E. Lindsay, W. S. Murray, Frank Rhea, J. M. Reid, A. F. Robinson, J. R. Savage, Martin Schreiber, W. I. Trench, H. U. Wallace.

Your Committee presents herewith its annual report for the year 1912.

(1) CLEARANCES.

Your Committee submits the following report as one of progress and information:

This Committee has considered a communication calling attention to interference with the bridge clearance line of the Association by the recently adopted third rail, permanent way structures and rolling equipment clearance lines, and has made a recommendation to the Committee on Iron and Steel Structures that as much of the bridge clearance diagram as interferes with the third rail and permanent way structures clearance line be eliminated, and in place thereof the clearance line for permanent way structures be substituted on roads where electric equipment is likely to be used.

The Committee on heavy electric traction of the American Electric Railway Association submitted a report at the annual meeting held at Chicago in October, 1912, which report recommended clearance lines for third rail, permanent way structures and rolling equipment identical with the lines adopted by this Association at its last meeting, and also submitted for information and guidance a suggested clearance diagram for automatic stops, with the recommendation that the matter be continued to allow the Committee time to confer with similar committees of this Association and the American Railway Association. The American Railway Association at its meeting in May, 1912, adopted a clearance diagram for third rail, permanent way structures and rolling equipment identical with the diagram adopted by this Association.

The Committee has been following up the progress made during the year on third rail installation and has had the table which accompanied last year's report brought up to date and same is resubmitted as information.

It is urged on the members of this Association that they try and induce their Companies to conform to the clearance diagram on all new work and gradually change over their present installation so that ultimately there can be a free interchange of electric equipment between the various roads.

The Committee has been collecting during the year data in regard to overhead clearances and is studying same with a view of taking up this question during the coming year with committees of the

George W. Kittredge, Chairman Committee on Electricity.

American Electric Railway Association and the American Railway Association, so that joint recommendations for overhead clearance lines may be made by the respective committees of each Association.

The Committee is not prepared at this time to take up the question of clearance lines for automatic stops, but as soon as a device that is adapted to conditions obtaining on roads operated in the open has been perfected, the question of established clearance lines will be further considered.

(2) TRANSMISSION LINES AND CROSSINGS.

Your Committee desires to report progress on the consideration of modifications of the specifications for overhead crossings of electric light and power lines adopted by the Association at the last convention for Transmission Lines and Crossings as will be necessary to cover voltages over 70,000 and also the consideration of the revision of the specifications in paragraphs Nos. 10, 13, 18, 24, 29, 31, 32, 34, 45, 49, 51, 55, 60 and 61, which were adopted by the Association with the understanding that the revision of these particular paragraphs would be considered this year.

Your Committee, however, is not prepared at this time to make any further recommendations, for the reason that more time is required to study the development of the art in respect to voltages over 70,000 and further because of the fact that the committees of all the various engineering associations have not as yet arrived at an acceptable joint specification.

(3) ELECTROLYSIS.

An invitation has been received from the American Electric Railway Association to unite with them in jointly considering the subject of "Electrolysis," and your Chairman has appointed Messrs. Katte, Gibbs and Brumley to serve on this Joint Committee with Messrs. Schreiber, Trench and Wallace, the members appointed by the American Electric Railway Association.

Your Committee submits the following report with recommendations that it be printed in the Proceedings of the Association as information.

Introduction.—The effect of electrolysis upon steel and iron structures, including water, gas and electric conduit pipes, also on the lead sheaths of insulated cables, has been a matter of serious concern ever since the first street car was operated electrically by means of a grounded return, but not until the advent of electrification on steam railroads did the subject become one of much interest to railway engineers. The matter is receiving the careful consideration of electrical engineers in conference with structural engineers and representatives of various municipal departments, but up to the present time there is no unanimity of opinion as to the best methods of preventing electrolysis, or for protecting metal structures adjacent to the path of grounded return circuits. For this reason your Committee cannot recommend any standards or preferred practice, but have compiled for your information a statement of methods pursued and a description of the research work now under way at some of the more important localities of particular interest to railway engineers.

In addition to this brief description of actual conditions there has been prepared a short explanation of the phenomenon of electrolysis and the more common methods of preventing its action; also a list of reference books and papers dealing with the electrolytic problem is appended to this report.

Nature of Electrolysis.

Electrolysis as referred to in the Electric Railway discussions may be described as the wasting away or corrosion of a metal which is caused by an electric current passing from one metallic conductor to another conductor where both are buried in damp earth, or other semi-conducting medium.

Causes and Effect of Electrolysis.

In direct current railway circuits the electric current passes from the power station or sub-station to the trolley wire or third rail, then through the motors of electric cars or locomotives and back to the station by the track rails. Owing, however, to the fact that it is practically impossible at all times to insulate the rails adjacent to the ground, part of the current leaks into the earth and finds its way back to the station through the ground, and in doing so, if pipes, cable sheaths or steel work are under or adjacent and parallel to the tracks, some of it may return by these metallic structures.

At some point or points this current must leave these metallic structures, and usually does through the earth in the neighborhood of the power station or sub-station, causing electrolytic effects in the underground structure or conductor at the points in question, unless precautions have been taken, as later indicated.

There is no less opportunity for current to escape from the tracks on electrified roads where the rails are above ground and rest on wooden ties in ballast, and there is no opportunity for such escape where the return circuit does not enter the running rails but is conducted back to the power station by independent and insulated contact rails or wires. Examples of this method of construction are found in slot conduit street railways and those having double overhead trolleys; also in those using a separate insulated return conductor rail.

It is common practice to connect the negative bus-bars in the power station or sub-stations with the running rails by copper cables at the points nearest to the stations. Such a connection is shown in Fig. 1. Leakage of current from the rails to the adjacent water pipes along the line may thus occur and the current flowing in these pipes leaves them and returns to the rails in the neighborhood of the power station, causing electrolysis at the points where it passes from the pipes through the earth.

Prevention of Electrolysis.

It is possible to prevent electrolysis by precluding the escape of electric current from the return conductors, but frequently this is not practicably possible as in the case of buried rails carrying return current. Several methods of meeting this latter condition have been employed, briefly described as follows:

(a) *Drainage System.*—In order to prevent this escape of current into the earth, negative cables are sometimes run from the power station or sub-station to adjacent pipes or metal work so that the current will leave these structures through metallic paths, thus preventing electrolysis at such points. This system is successfully used in connection with continuous cable sheaths or pipe lines having screw joints, although it results in inducing a larger volume of flow by these paths. It is objectionable, however, in water pipe lines having lead joints, as frequently electrolysis is induced at the pipe joints as shown in Fig. 2. This method of reducing electrolysis is known as the Drainage System.

(b) *Insulated Negative System.*—Another system employed is to provide insulated cables which are connected to the rails at points remote from the station. This style of connection is shown in Fig. 3. It is largely employed in Europe and is beginning to be specified in connection with the American systems. This has the effect of maintaining a more uniform and lower negative potential and largely prevents the current from leaving the bonded rails. The objection to this system is the high cost of the insulated copper cables, which must be relatively very large and which do not carry current to their full capacity.

(c) *Booster System.*—A modification of the above system devised to compel the cables to carry current to their full capacity is known as the Booster System. In this system the cables carrying return current are connected to a low potential generator of large capacity, which acts like a pump placed in a pipe line of low flow head to increase the volume of flow. This style of connection is shown in Fig. 4.

(d) *Other Systems.*—There are sometimes peculiar local conditions of which advantage can be taken by an electrical engineer, but usually one or the other of the above systems, or combinations of them, are employed to safeguard metallic structures adjacent to the path of the return current.

Discussion.

George W. Kittredge (N. Y. C. & H. R. R. R.): This report is submitted as progress and information only. (Mr. Kittredge suggested several minor changes.)

C. S. Churchill (N. & W. Ry.): If there are no objections the report will be accepted with changes. The Committee is dismissed with the thanks of the Association.

CONSERVATION OF NATURAL RESOURCES.

William McNab, *Chairman;* W. A. McGonagle, R. H. Aishton, Moses Burpee, F. F. Busteed, A. W. Carpenter, C. H. Fisk, G. A. Mountain, W. L. Park, G. H. Webb, R. C. Young.

The Committee has under consideration the fostering of closer relations between it and the officers of the National Commission, as well as with the National Association of State Conservation Commissioners and the Western Forestry and Conservation Association, believing as it does that more officially recognized co-operation with these Associations would be conducive to the attaining of the general objects for which Conservation Commissions were established, and more particularly those features in which the railways are vitally interested.

TREE PLANTING AND REFORESTATION.

Dominion of Canada.

The Forestry Branch, Department of the Interior, has taken the lead in connection with forest planting in Canada. The forest nursery at Indian Head, Sask., has been furnishing a constantly increasing amount of plant material for free distribution among the farmers of the Prairie Provinces. The number of trees and cuttings sent out has increased steadily from 48,000 in 1901 to 2,729,135 in 1912, with a total, all told, of approximately 23,000,000. These trees are scattered in small plantations throughout the settled portions of Alberta, Saskatchewan and Manitoba, so the actual showing is much greater than the number alone would indicate. The force of example will unquestionably cause the rapid spread of the tree-planting idea with the passage of time.

Trees are sought for planting in the prairies chiefly on account of their value as windbreaks. When properly planted and cared for, they afford great protection from wind to crops, stock and buildings, and thus add materially to the value of the farm. A secondary consideration is that of fuel supply, in which, however, the farm woodlot will ultimately prove an important factor.

In addition to supplying trees for distribution to farmers, the Forestry Branch is inaugurating a policy of reforestation on the Dominion Forest Reserves in the Prairie Provinces. Some of these reserves, entirely surrounded by large farming sections, formerly supported a good forest growth, but are now largely denuded as a result of forest fires. The reforestation of these areas is of great economic importance as centers from which the farming population may secure fuel and other wood supplies.

The Department of Agriculture of the Province of Ontario has, since 1904, encouraged the development of farmers' woodlots, through the distribution of trees and cuttings.

The principal tree-planting activity in the Province of Quebec has been in connection with the fixation of certain areas of shifting sands in the eastern portion of the Province. About 300 acres of shifting sands at Lachute have been purchased at $1.00 an acre from farmers who have the privilege of buying it back within the first fifteen years at a price covering the original cost, the cost of reforestation and interest at 4 per cent. The Province, however, guarantees that the cost of such repurchased lands shall not exceed $10.00 an acre. On the area purchased, 40,000 white pine, white spruce, elm and green ash seedlings were planted in 1912. At Berthierville there is a government forest nursery where forestry students are trained each spring in reforestation.

The Canadian Pacific Railway has done considerable planting

along its line in the prairie sections in places where there has been trouble with drifting snow. The intention is to secure a growth of trees which shall replace the numerous snow fences along portions of the line. This Company is also encouraging the planting of trees and shrubs for shelter-belt purposes by farmers who have purchased land from the Company in specified sections of Southern Alberta. One-half the trees required are furnished free, and prizes are offered for the best plantations.

PREVENTION OF FIRES FROM RAILWAYS.

On May 22, 1912, the Board of Railway Commissioners for Canada issued an order requiring railways subject to its jurisdiction to take certain measures for the prevention of forest and grass fires along their lines. This order, a copy of which is appended hereto, included in a slightly modified form provisions contained in former orders for the use and inspection of fire protective appliances on locomotives, the construction of fire guards in the Prairie Provinces and the non-use of lignite coal. In addition, provision was made for the appointment of a chief fire inspector, who is given authority to prescribe special patrols to be maintained by the railway companies where such action is considered necessary. The regulation of the burning of inflammable material along rights-of-way during the fire season is also provided for. Railway employes are required to report and extinguish railway fires, and any fires starting or burning within 300 feet of the track are presumed to have started from the railway, unless proof to the contrary is furnished.

Regulations of a similar nature have been issued by the Public Utilities Commission of the Province of Quebec, applicable to provincially chartered railways. The prevention of railway fires along provincially chartered lines in British Columbia, through the adoption of similar measures, is provided for by the new Forest Act, which became a law early in 1912.

COAL RESOURCES.

As a result of an investigation by the Commission of Conservation it was found that there was in Saskatchewan, Alberta and British Columbia a considerable waste of slack coal which had been mined and brought to the surface. This waste of unmarketable slack coal varies from 10 to 35 per cent of the output. In Saskatchewan, 10 to 25 per cent of the output from the mines is slack coal, which is dumped on the ground and wasted. In the vicinity of Estevan, 10 to 12 per cent of the output from some of the larger mines is dumped on the prairie and burned. It is necessary to remove this coal (lignite) from the mine plant, as it readily ignites by spontaneous combustion.

The waste of slack coal varies from 10 to 12 per cent in the Lethbridge district, and from 20 to 35 per cent in the Edmonton district. In the Crow's Nest Pass district, in Alberta and British Columbia the coal is of better grade and some of the slack is marketable; the remainder is made into coke in beehive coke ovens. At Bankhead, briquettes are made from the slack coal. On Vancouver Island, some of the large producing mines waste from 10 to 15 per cent of their output as slack coal, and, unfortunately, it is generally dumped into the sea. The high freight rates make it impossible to market this slack at a profit.

In order to save to the community what amounts to more than 15 per cent of the total output of coal, besides the low-grade coal which is often left in the mine; it was suggested that the following studies be made:

(1) To ascertain the price of coal in different parts of the West, and which portions of the country are supplied with coal from the different mining centers, also the prices of coal in Canada and the freight rates on the same from the mines to the market.

(2) Owing to the necessity of obtaining a suitable domestic fuel and cheap power for the Prairie Provinces, it is desirable that investigations be carried on with a view to utilizing the lignites which underlie the greater portion of these provinces. In this connection it is of interest to know that the United States Bureau of Mines has demonstrated that suitable briquettes can be made from low-grade lignites. The Bureau has also shown that many fuels of such low grade as to be practically valueless for steaming purposes, including slack coal, bone coal, and lignite, may be economically converted into producer gas and may thus generate sufficient power to render them of high commercial value.

PEAT DEPOSITS.

The Fuel Testing Division of the Mines Branch, Ottawa, has recently carried on experiments on the utilization of peat fuel for the production of power. The tests were carried on in a 60-horsepower double-zone "Korting" peat gas producer, and a 60-horsepower, four-stroke cycle, single-acting "Korting" gas engine. The results of this investigation are published in a report on the Utilization of Peat Fuel for the Production of Power.

Reliability.

The peat producer-gas power plant, as now constructed, may be pronounced thoroughly reliable. Its operation may be carried on continuously for a week or more without having to shut down for the purpose of cleaning the valves of the engine. The engine has been operated for a period of 150 hours without removing either the admission or mixing valves for cleaning.

It should not be found necessary, in commercial practice, to remove the piston for the purpose of cleaning, more than once in six months.

The operation of the producer is uniform, and the gas delivered to the engine varies only slightly during a ten-hours' run. The removal of ashes, and the cleaning of the fires, can be done without inferfering with the operation of the engine, due to a change in the quality of the gas.

Fuel Consumption.

The consumption of fuel per brake-horsepower hour—including stand-by losses—is for full load, 1.7 lbs. of dry peat, or 2.3 lbs. of peat containing 25 per cent moisture; for three-fourths load, the fuel consumption—including stand-by losses—is 2.1 lbs. of dry peat, or 2.8 lbs. of peat containing 25 per cent moisture.

Cost of Fuel.

In estimating fuel costs, the assumption is made that peat with a moisture content of 25 per cent can be delivered to the producer for $2 per ton. In order, however, to take advantage of this, or a lower cost for fuel, the power plant will have to be situated at or near the bog where the peat fuel is manufactured. For small plants of the type and capacity described in the foregoing remarks this might not prove feasible in many cases, but will prove entirely feasible and practicable when the plants are of large capacity and when the energy developed is transmitted, in the form of electricity, to neighboring towns and villages, for lighting, power and other purposes.

Since the fuel burned in the producer does not require to be of the best quality, the fuel cost may be considerably reduced, since the broken peat bricks and considerable fines—which always occur in the manufacture of peat and otherwise, represent a loss—can be efficiently utilized in the producer. Assuming, however, that peat can be delivered to the plant for $2 per ton, and that the plant is run with a power-factor of 75 per cent for 3,000 hours, the fuel costs would be $8.40 per B.H.P. year, including stand-by losses.

NATURAL GAS IN CANADA.

The production of natural gas in Canada has increased in value nearly thirteen-fold during the last nineteen years, and of the total amount the Province of Ontario produced about 94 per cent. Steps were taken by the Ontario government in 1907 to prevent the waste of natural gas, and a law was passed levying a tax of two cents per 1,000 ft., with a rebate of 90 per cent when the gas is used in Canada. This provision has been very effective. In Alberta little provision has as yet been made for the plugging of the gas wells, and many millions of cubic feet have therefore been wasted annually and extended areas have been more or less drained.

In 1912 there has been considerable natural gas developments in New Brunswick and Alberta. In New Brunswick the city of Moncton is supplied from one of seventeen wells situated in Albert County, about 11 miles distant.

In Alberta, the Canadian Western Natural Gas, Light, Heat and Power Company, Limited, has completed 15 natural gas wells in the vicinity of Bow Island, Alberta, from which gas is now being piped to Calgary, a distance of 175 miles. In addition to supplying Calgary, the company has branch lines to Lethbridge, MacLeod, Granum, Nanton, Claresholm, Brooks and Okotoks.

PETROLEUM RESOURCES.

While the actual petroleum resources of Canada are comparatively small, nevertheless, the potential resources are considerable. In New Brunswick and Nova Scotia there are enormous deposits of oil shales which are valuable as a source of oil. On an average these shales will give a higher yield of crude oil per ton than the oil shales worked so extensively in Scotland.

In the vicinity of Fort McMurray and Fort McKay, on the Athabaska River, Alberta, there are enormous deposits of tar sands. The bitumen in the tar sands is the residue from evaporated petroleum. It has been estimated that there is 6½ cubic miles of solid bitumen in the tar sands exposed on this river.

Although enormous quantities of oil have evaporated from this district, nevertheless it seems probable that accumulations of petroleum may exist in places where the geological structure was such as to prevent its escape. This is also exemplified by the fact that natural gas occurs in quantity in districts where the tar sands are capped by overlying measures.

If large quantities of petroleum were discovered in Alberta it would be a factor of great importance to the railway interests which operate in the Rocky Mountains and Jasper Parks and the forest areas in British Columbia and Alberta.

The Canadian Pacific Ry. is now using oil-burning engines on its main line between Kamloops and Field, in British Columbia. The Grand Trunk Pacific and some of the Canadian Pacific coast steamships also burn oil, and other boats are being changed from coal-burners to oil-burners. The oil is at present obtained from the California oil fields. If supplies can be obtained at the prices now prevailing, its use will be very largely extended. Its cleanliness, the greatly decreased smoke, the decrease in the number of firemen required, the economy, particularly in intermittent service, the increased efficiency—two boilers with oil, in steamship service, giving the same steam as three with coal—and other considerations, make it an almost ideal fuel.

Discussion.

L. A. Downs (I. C. R. R.): I don't see why this Association has a committee on Conservation of Natural Resources. We have never really run out of anything. I think we should have a committee to prevent waste—forest fires, etc.

Prof. S. N. Williams (Cornell College): We have suffered for the last four or five years from forest fires to the extent of millions of dollars. I think this committee one of our most important ones we have.

G. W. Andrews (B. & O. R. R.): There has been gross waste of timber in this country, and the railways have been the heaviest losers.

J. L. Campbell (E. P. & S. W. Ry.): I understand conservation also includes economical use of materials, and I think we all agree on this question.

The report was accepted and the committee was relieved.

BALLAST.

H. E. Hale, Chairman; J. M. Meade, Vice-Chairman; W. J. Bergen, A. F. Blaess, L. W. Baldwin, T. C. Burpee, O. H. Crittenden, F. T. Darrow, J. M. Egan, T. W. Fatherson, H. L. Gordon, G. H. Harris, C. C. Hill, S. A. Jordon, William McNab, A. S. More, J. V. Neubert, S. B. Rice, E. V. Smith, F. J. Stimson, S. N. Williams.

The work assigned to the Ballast Committee was divided between three sub-committees, as follows:

(A) REPORT ON PROPER DEPTH OF BALLAST OF VARIOUS KINDS TO INSURE UNIFORM DISTRIBUTION OF LOADS ON ROADWAY, CONFERRING WITH COMMITTEE ON ROADWAY.

Sub-Committee: H. E. Hale, Chairman; W. J. Bergen, T. C. Burpee, O. H. Crittenden, J. M. Egan, T. W. Fatherson, G. H. Harris, C. C. Hill, A. S. More, E. V. Smith, F. J. Stimson, Wm. McNab.

In last year's report on this subject your committee had as a basis for its report several reliable and thorough tests, such as the tests made by the Pennsylvania Railroad at Altoona and by Director Schubert, of the German Railways, in Germany, and on the information obtained for these tests your committee drew its conclusions and made its recommendations to the Association, which recommendations covered the subject as far as the information permitted. These recommendations were printed on page 97, in the report of 1912, and adopted by the Association, but the subject in a modified form was again referred to the committee.

The tests on which the committee based their conclusions have been conducted largely under artificial conditions, which were designed to be, as nearly as possible, those which actually existed in the track under regular traffic, but under the circumstances it was impossible to absolutely reproduce conditions existing in track under regular traffic.

Careful search has been made to obtain reports or results of tests on this subject, both in foreign and American engineering papers, and this search has been practically without result. It therefore appears that if further investigation or report is to be made by your committee, it must be based on new tests, which should be made in track under regular traffic—preferably heavy traffic.

Discussion of this subject by the committee with other members of the Association has led the committee to believe that many members of the Association feel that a further test in track under regular traffic is desirable, and to place this before the Association in tangible form, your committee has worked out the following proposed test:

Proposed Test to Determine Proper Depth of Ballast of Various Kinds to Insure Uniform Distribution of Loads on the Roadway.

(1) Select a stretch of track on clay roadbed, under heavy traffic, where trouble has been experienced with clay working up between the ties.

(2) Excavate roadbed to a uniform depth of 30 in. below the bottom of the ties, for a space of two rail lengths; prepare the adjacent rail lengths in the same manner, decreasing the depth 3 in. under each successive two rails, until the bed is 12 in. below the bottom of the tie (14 rail lengths).

(3) Place on this bed a thin layer of fibrous material, such as hay, to make a well-defined separation between roadbed and ballast.

(4) Place stone ballast on bed to the above-mentioned depths, tamp well, and put track in good line and surface.

(5) Make note of tie spacing, width of ties, keep accurate levels and record of amount of time spent on surfacing various parts of track, also keep record of axle loads and amount of traffic. Take photographs at regular intervals to show deformation of roadbed.

(6) Make similar test for gravel and similar for ballast section, having a sub-ballast of gravel equal to one-half the total depth and a top ballast of stone equal to one-half the total depth of ballast.

(7) The estimated cost of this test is as follows:

(a)	Cost of material (stone), 500 yds. at 80 cents	$ 400.00
(b)	Labor, preparing track and widening bank, where necessary, at $20.00 per rail (14 rails per test)	420.00
(c)	Labor, inspecting, six inspections at $2.00 per rail	170.00
(d)	Line and surface to be paid for by railway owning track, at regular maintenance charge	00.00
	Total for one test	$ 990.00
	Three tests	$3,000.00

Conclusion.

Your committee recommends that the above test be made under the direction and supervision of the Ballast Committee, and that same be financed by the Association or some railroad or railroads. The location for the test to be arranged for by the committee with a railroad that would be willing to have this test made in their main tracks under heavy, regular traffic.

(B) CONTINUE STUDY OF PHYSICAL TESTS OF STONE FOR BALLAST.

Sub-Committee: S. A. Jordan, Chairman; S. B. Rice, H. L. Gordon, J. V. Neubert.

Further investigations by the committee this year resulted in practically no additional information except a paper read at the Sixth Congress in New York of the International Society for Testing Materials by A. T. Goldbeck and F. M. Jackson, which quoted, in part, the table and data given in the American Railway Engineering Association report of 1912 and practically gave the same information as given in our reports.

The table showing results of physical test of stone for ballast, as presented to the Association last year, has been checked, and the various railroads represented have advised that they had nothing further to add to the table. This table is considered by your committee to be a very good guide for comparing stone from various quarries when selecting same for ballast.

The further consideration of the physical tests of stone for ballast by the committee resulted in their recommending the physical tests

H. E. Hale, Chairman Committee on Ballast.

as a guide only in the specifications for stone ballast, and it is recommended that the following note be added in the Manual to the specifications for stone ballast.

Conclusion.

NOTE—*"Attention is called to the physical tests of stone for ballast printed in the Manual, page 47, which are recommended as a guide, in connection with these specifications."*

After further consideration of this subject, your committee feels that the information, as at present printed in the Manual in regard to the physical tests of stone for ballast, was not clear to some of those who were not familiar with the subject, and it is recommended that the information given in the Manual on this subject on page 47, under the heading of "Physical Tests of Stone for Ballast," be changed to read as follows (portion in italics is additional):

"It is recommended that the following be used for physical tests of stone ballast. *Other things being equal the maximum or minimum results as indicated will govern in selecting stone for ballast:*

(a) Weight per cubic foot—Maximum.
(b) Water absorption in pounds per cubic foot—Minimum.
(c) Per cent of wear—Minimum.
(d) Hardness—Maximum.
(e) Toughness—Maximum.
(f) Cementing value—Minimum.
(g) Compression test—Maximum."

For the description of the physical tests of stone for ballast as recommended by the Association and full instructions as to how the samples should be obtained and shipped to the government for test (test made free of charge by the United States Government), see Proceedings of the American Railway Engineering Association, Vol. 11, Part 2, pp. 910-914, and report of Ballast Committee of 1912. If blue prints of the machine used in making the tests are desired, they can be obtained from the Department of Agriculture, United States Government, Washington, D. C.

SIZE OF STONE BALLAST.

Your committee wishes to present to the Association a copy of a report of a test made by the Pennsylvania Railroad in regard to the first cost of putting in ballast and maintaining same for various sizes of stone ballast; the report is given below.

Sizes of Ballast.

Investigation conducted by the Pennsylvania Company between August, 1899, and October, 1903, inclusive, record of experimental tests of three different sizes of broken stone ballast:

	Size of Stone Ballast.		
	¾ in.	1½ in.	2½ in.
Double track ballast, feet	5,280	5,211	5,280
Double track ballast, miles	1.0	0.987	1.0
Stone ballast used, cars	228	171	198
Stone ballast used, tons	6,200.5	4,651.8	4,947.9
Cars stone per mile double track	228	173	198
Tons stone per mile double track	6,200	4,713	4,948
Linear feet double track to 1 car	23.1	30.5	26.7
Linear feet double track to 1 ton	.85	1.12	1.07
Average depth ballast under ties	7.25 in.	6.5 in.	6.75 in.
Total first cost of ballast, freight, unloading, putting in tracks, lining and surfacing, etc.	$7,911.60	$5,633.51	$5,263.92
Average cost per foot double track	1.50	1.08	.997
Average cost per mile double track	7,911.60	5,708.10	5,263.92
Cost ballast per ton at quarry	60–70c	60–68c	58–69c
Average cost of maintenance for period of 51 months, per mile	94.66	84.94	82.13

Conclusion.

After considering this information, your committee does not wish to make any change in the size of stone for ballast, as now recommended in the Manual.

(C) CONTINUE INVESTIGATION ON GRAVEL BALLAST AND RECOMMENDED METHODS OF GRADING DIFFERENT QUALITIES.

Sub-Committee: J. M. Meade, Chairman; F. T. Darrow, S. N. Williams, A. F. Blaess, L. W. Baldwin.

Your committee has made extensive tests in regard to classification of gravel for ballast in past years. During this year, Mr. Meade, Chairman of the sub-committee on this subject, had a very thorough test made, which is presented herewith.

Tests made last year of river gravel gave results that indicated that gravel which was much higher in sand than called for in the Manual for first-class roadbed gave first-class results, and, therefore, the committee was unwilling to approve the former recommendations, but further investigations this year show that the reason for this discrepancy was largely due to the use of improper screens and different methods of selecting the sample. Your committee, therefore, wishes to incorporate in the Manual a brief but complete description of the method of making the test of grading gravel for ballast, as follows:

Conclusion.

Method of Testing Quality of Gravel for Ballast.

(1) The size of the sample to be tested should be approximately one cubic foot.

(2) Five average samples of about one cubic foot each should be selected from various parts of the pit, which is to be tested. The five samples should then be thoroughly mixed and about one cubic foot of the mixture selected for testing.

(3) To separate the gravel from the sand and dust use a No. ten (10) screen (ten meshes to the inch), made of No. 24 wire (B. & S. gage); to separate the sand from the dust use a No. fifty (50) screen (fifty meshes to the inch), made of No. 31 wire (B. & S. gage).

(4) Measure the percentage of gravel, sand and dust taken from the sample by volume, giving the percentage of each ingredient, compared to the volume of the sum of the ingredients, as follows:

$$\text{Per cent of sand} = \frac{S}{G + S + D}$$

Where S = Volume of sand.
G = Volume of gravel.
D = Volume of dust.

(5) When sample is shipped for test it should be carefully and securely marked with name and location of the pit from which it was taken.

The above will necessitate canceling the following paragraph on page 47 in the Manual. "The term percentage above is used to indicate the proportion of the original bulk."

Per Cent of Sand in Gravel.

Examination of Appendix A will indicate a considerable variation of per cent of sand and dust found in gravel taken from various rivers, although the results obtained from the use of those gravels for ballast is reported as satisfactory from various railroads which use them. The fact that some gravel which is high in sand and dust is reported as giving good results, it is believed, is due to the fact that it is the best material available for ballast in that locality, but your committee feels that from tests made at ballast washing plants, the percentage given in the Manual for washed gravel will give very satisfactory results.

CLEANING STONE BALLAST.

Appendix B is a copy of report on cleaning stone ballast made by Mr. W. I. Trench, Division Engineer, to Mr. S. A. Jordan, Engineer Maintenance of Way, of the Baltimore & Ohio Railroad, which report was forwarded to the chairman after the last Ballast Committee meeting and is included as information. The investigation by Division Engineer Trench and Supervisor Zepp has resulted in a very material saving in this class of work.

Recommendations for Next Year's Work.

Your committee recommends the following subjects for investigation for the year 1913:

(1) Further investigation of the proper depth of ballast of various kinds to insure uniform distribution of loads on roadway.

(2) Revise the ballast sections, with particular reference to the use of a sub and top ballast.

(3) Investigate methods of cleaning stone ballast and obtain cost of same by various methods.

Discussion.

J. R. Leighty (M. P. Ry.):—I think the distances are too short in the test section as outlined by the committee. The conditions on one of these short sections will greatly affect the adjacent sections.

E. A. Hadley (M. P. Ry): From the per cent of sand I would understand per cent of a solid cubic yard. This method will show an increase of six to eight per cent in percentage of sand. The committee has evidently neglected the voids in this formula.

H. E. Hale (M. P. Ry.): If we add the voids to the 100% by the old method, we will get 130 to 140%, which is very unsatisfactory in practice. The gravel companies are using the suggested method.

E. A. Hadley (M. P. Ry.) The voids are a minus quantity, and therefore would not increase the percentage over 100.

The Convention accepted the clause as submitted.

S. B. Rice (R. F. & P. R. R.): We started gravel washing at a pit in the middle of our line in 1908, and have reballasted the entire line since, 57 miles each side of the gravel pit. The average cost in finished track was less than 58 cents, distributed as follows: Loading, 8½ cents; washing, 11½ cents; hauling, 13½ cents; placing in track, 24½ cents. Maintenance on this track was $19.00 per mile per month, under traffic of 24 passenger and 22 freight trains.

BUILDINGS.

Maurice Coburn, Chairman; M. A. Long, Vice-Chairman; G. W. Andrews, J. P. Canty, O. P. Chamberlain, D. R. Collin, C. G. Delo, W. T. Dorrance, C. H. Fake, C. F. W. Felt, W. H. Finley, G. H. Gilbert, A. T. Hawk, H. A. Lloyd, L. G. Morphy, C. W. Richey, W. S. Thompson.

The following subjects were assigned to the committee by the Board of Direction:

(1) Present principles covering the design of inbound and outbound freight houses.

(2) Report on recommended methods of heating, lighting and sanitary provisions for medium-sized stations.

(3) Complete report on roof coverings.

(4) Report on the advantages and disadvantages of various types of freight house floor construction.

Progress is reported on subject (1).

Reports on (3) and (4) are presented herewith.

No recommendations are made as to revision of the Manual.

(3) REPORT ON ROOFING.

The following report on roofing combines the matter presented in the reports of the two past years, with some corrections and some additions.

The committee is of the opinion that much of this report on roofing should go into the Manual. We would like, if possible, to have this in the next edition. The report is too long to go over in detail at the convention, and members interested are asked to go over it carefully, and be prepared to discuss it at the convention, if they disagree in any parts.

In the revision, we are particularly indebted to Prof. A. L. Dean, of Yale University, for valuable criticism and information in connection with the bituminous materials.

THE BITUMINOUS ROOFING MATERIALS.

The bituminous roofing materials are varied and complex and what accurate knowledge there is about them is largely held by the experienced manufacturers.

There is yet much to be learned, and even if our report accomplished its aim of presenting accurately the present available knowledge of this subject, it would soon be out of date.

The bitumen substances are organic compounds, largely composed of many different hydrocarbons, with different chemical formulæ and widely-varying melting points. They vary so and the knowledge concerning them is so limited and new that considerable confusion exists in regard to nomenclature and classifications. They are always accompanied by greater or less amounts of impurities, and are obtained either naturally or as the heavier distillates or residues of coal, petroleum or other organic substances. Their distinguishing characteristics are their elasticity and binding power or adhesiveness,

their considerable immunity from action by water and their solubility in oils and certain other organic compounds.

In the commercial preparation of the different bitumens obtained from coal and petroleum, distillation is used to mechanically divide them into classes of compounds having similar physical qualities. When in this process sufficient heat is applied to cause a chemical breaking down of some of the hydrocarbons, the operation is termed cracking.

Asphalt.—The term asphalt is ordinarily considered as referring to bitumens found naturally in the solid state and will be so used in this discussion.

The asphalts are generally stable in the atmosphere. As found naturally, they are not commercially available, even after the impurities are removed, being too hard and brittle for most purposes. This is ordinarily remedied by softening or fluxing with various oils, an operation requiring skill. The character of the fluxes has a most important effect upon the finished product. Petroleum products are ordinarily depended on for this purpose. The fluxes should be sufficiently stable to insure against too rapid hardening of the fluxed asphalt. They should be free from deleterious constituents and should be of such a character that they will combine with the asphalt to be fluxed so as to make a homogeneous and perfect solution. Certain fluxes which work well with certain asphalts are not at all suitable for use with other asphalts. Tars are sometimes employed for fluxing purposes, but they do not mix easily with the asphalt. As asphaltic compounds age they tend to become brittle and hard, losing their elasticity and binding power. Poor fluxing hastens this process.

A single asphalt fluxed by a single oil is ordinarily an imperfect and unsatisfactory roofing material, the oil having a tendency to separate out and evaporate, leaving the remainder hard and brittle. The fibre of the rag felts ordinarily used in roofing work are supposed, by capillary action, to hasten this process with asphalts used as saturants. The successful asphaltic roofing compounds are ordinarily composed of several different materials.

Commercial refined asphalts, intelligently and honestly refined, should and do run very uniform. When they are compounded, however, brand names have very little significance and less value, and should not be taken in themselves as indicative of the character or value of the compound. Some types of asphaltic compounds properly prepared and used have qualities which make them almost indispensable for some classes of roofing.

THE TARS.

Coal Tar.—From the distillation of bituminous coal, either in a plant for the production of illuminating gas or in a by-product coke oven, the products may be roughly divided into four classes, the gas, the ammoniacal liquor, which is the scrubbing water with the materials which it has absorbed from the distillates and which it holds in solution, the coal tar, a heavy liquid containing the distillates insoluble in water which have settled away from the ammoniacal liquor, and the coke.

The coal tar contains some water, various impurities and free carbon which, after the water has been removed, is ordinarily from five to thirty-five per cent of the total. This is carbon formed by the cracking of the hydrocarbons and is in a very finely divided condition. The percentage varies with the method of manufacture. The distillates or bitumen are composed mainly of hydrocarbons which have widely varying melting points and degrees of volatility. These may be roughly classified into light oils, creosotes and pitches. The character of the tar varies with the coal used and the manner in which the process is carried on. The tar from each plant has its individual characteristics. The greater the heat, the more the hydrocarbons are cracked into their constituents and the greater the amount of free carbon and of gas found and the less the amount of coal tar. By carrying the process to its theoretical limit the final products of distillation would be gas and carbon.

The question of the relation between free carbon and coal tar is one of considerable importance. It is generally considered to be a valuable adjunct to roofing tars and pitches. Free carbon makes the material less affected by changes in temperature. Comparing two pitches of similar consistency at normal temperatures, the one having the greater amount of free carbon must have to neutralize it a greater per cent of the lighter, more elastic and to some extent more volatile hydrocarbons and less of the heavy pitches. When it is cold the pitch is less brittle and when it is hot it does not flow so readily because of the carbon present. Thus a tar of given consistency may, notwithstanding the fact that it contains large quantities of an inert material, apparently have more life than another with less of the free carbon.

To determine the probable action of any tar or pitch under different temperatures its percentage of free carbon must be known as well as its melting point. The free carbon in moderate amounts does not interfere with the saturating power in felt.

When coal tar pitch is exposed to the weather there is found upon its surface a thin layer, hard and brittle, the residue after the drying out of the volatile oils. This acts as a sort of protective coating to what is underneath. As soon as it is disturbed, exposing fresh pitch, the process is repeated. High carbon tars seem to weather better than low carbon.

Water Gas Tars.—In making carburetted water gas, the procedure is as follows: Steam is blown through a bed of incandescent coal or coke, where it is broken up, forming blue water gas, which consists of about equal quantities of hydrogen and carbon monoxide. This gas, which has no illuminating value, is passed into a second chamber, which is filled with checker brick and which has been previously raised to a high temperature. Into this chamber is sprayed petroleum oil, which, by the intense heat, is broken down into permanent gas and a tar consisting, partly, of aromatic hydrocarbons similar to those occurring in coal tar. This permanent gas is of high illuminating value and imparts its luminosity to the blue water gas, while the tars drop out further on in the process of manufacture. It is from this tar that oil tar pitch and other products are obtained.

In the process which it undergoes the oil residues are so changed by the high heat as to lose many of their characteristics and to acquire some of those of the compounds found in coal tar. Compared with coal tar, its oils have less antiseptic properties. As obtained from the gas manufacturers it is thinner, containing more light oils, less of the pitches, and often more water. The oil tars are subject to considerable variation, depending upon the methods and materials used. They are distilled down and treated much as is coal tar and its pitch is very similar in appearance to that of coal tar.

Water gas tar contains some free carbon, but usually not over 2 per cent. Its pitch is not acted upon by water. There is a very general opinion among practical roofing men that the water gas tar products are less stable than the coal tar pitches, but we cannot find that there has been any accurate proof of this. Its small percentage of free carbon materially interferes with its value as a roofing pitch. It is said that carbon can be added, but we doubt the commercial practicability of such a scheme.

Oil tar decomposes more easily than coal tar. It often contains some paraffine, though ordinarily not in sufficient quantities to affect the product as compared with coal tar. The crude water gas tar is also much more affected by water and is capable to a considerable extent of forming an emulsion with it. Good coal tar is practically unaffected by water, and it deteriorates from the surface only.

Water gas is now made practically everywhere and ordinarily mixed with coal gas. In one large plant from the same amounts of gas the water gas produces about a third of the amount of tar that coal gas does. The coal gas, considering its by-products, is under favorable conditions the cheaper, but the water gas requires less of a plant and allows greater flexibility of operation. The prices of materials and the demand for coke affect the relative outputs. In the large plant previously spoken of the proportions of coal and water gas made vary between two and three of water gas to one of coal gas.

In the larger illuminating gas plants the two sorts of tar are generally separated, but in many of the smaller plants they are mixed together. There is no reason why they should not be kept separate except for the cost of separate receptacles. In this country the by-product oven and gas tars, both coal tar and water gas tars, are bought by a comparatively limited number of concerns, who closely guard their processes. They compound the different sorts possessing varying characteristics, endeavoring as far as possible with their supply and their desire for maximum profits to meet the needs and demands of the consumer. The consumer in his ignorance does not know what he is getting and probably usually does not know what he needs. The detection of oil tar in coal tar products is a difficult and uncertain matter, especially when it is under twenty-five per cent of the total. We are not sure that it has been proven that a reasonable amount of water gas tar seriously injures a coal tar for roofing purposes, especially when used as a saturant, although it is generally in disfavor.

Not long since practically the only use of tar was for roofing and the entire supply came from the manufacture of illuminating gas from coal. The situation has been changed by the increasing supply from by-product ovens, by the manufacture of water gas in large quantities, by the great demand for creosote oils and other by-products, by the use of coal tar pitch for waterproofing masonry, by its use for briquetting coal slack and by its adoption for use as a road binder.

We would sum up the remarks on the bituminous materials as follows:

With skill in compounding, based on a thorough working knowledge of the materials used, asphaltic compounds can be prepared of natural asphalts and oil residuals with valuable qualities for many different roofing needs, whose durability under known conditions can be foretold with considerable accuracy. The same can be said, perhaps with more certainty as to results, of the different tars. Either can suffer from adulteration and poor preparation. Considering first-class materials the coal tar is cheaper, more easily affected by temperature changes and is not acted upon by water nor is it liable to internal changes.

From these compounds the only definite information that can be furnished by laboratory tests as to probable life and weathering properties is negative in its nature and quite inconclusive. Specifications to be enforced must include factory inspection and knowledge of materials used.

In order to meet the statements concerning the difficulties in get-

ting, at the present time uniform straight run coal tar pitch of good quality, the leading manufacturer of coal tar is making arrangements with the Underwriters' Laboratories to make factory inspection of his labeled products. Preparations for this are being made in a thorough manner and competitors, to put their products in the same class, must also arrange for the same inspection. This, together with the specifications, enlarges considerably the possibility of being sure of getting good materials for a built-up coal tar roof.

FELTS.

The felts used with almost all bituminous roofings play a very essential part in the final product.

The desirable qualities of the felt vary with the saturating material to be used. With asphalt saturating power is the main desideratum. For coal tar, which under heat is much more liquid, this quality is not so necessary. All must be strong enough to avoid damage in handling before saturation. The strength of the finished product is due to a great extent to the saturation.

The felts are mainly made of rag stock, which is chiefly cotton rags. Notwithstanding the statements of many manufacturers, all-wool felt is never used for roofing, because of its expense and because it would be too soft and tender to work. A certain proportion of wool rags helps to make a felt which is open and spongy with considerable saturating power. Felts for saturation by asphalt rarely contain more than 25 per cent of wool. As ordinarily used the term wool felt applies to a soft open felt with very little wool in it.

Sometimes paper stock, which is ordinarily wood pulp, though it may contain an appreciable percentage of straw, is used in small quantities if the felt is getting too soft. It has practically no saturating power, but it can add to the cheapness of the material. If used in anything over two or three per cent, it is an adulterant to cheapen the product when it is made to sell to roofing manufacturers, or to make it less absorbent, as in the case of slaters' felt or hard felt for making up into two and three ply coal tar felt.

The felt materials ordinarily come to the factory in large bales, already sorted with fair accuracy, and are bought according to different grades. These are used together in varying proportions to get different results and to meet variations in the materials. But little sorting is done at the plant except to watch for specially undesirable constituents.

The methods of manufacture have a considerable effect on the quality of the material. The felt must be well beaten to avoid large lumps, which are sources of weakness. The felt is made on a machine similar to that used for making ordinary paper and variations in its operation determine the quality of the finished products.

The dry felts are sold by weight. The standard is the amount which would lay 480 sq. ft. If a felt weighs 28 lbs. to 480 sq. ft., it is known as No. 28. For this reason felts sometimes have their weight increased by the addition of a mineral filler. This is nothing more than an adulterant which interferes with the saturating power. Some specifications which require a certain weight of felt get around such adulteration by requiring that the ash in the unsaturated felt must not exceed 5 per cent.

Felts of asbestos are used in one or two roofings. These are poor saturants and are more in the nature of protection to the asphalts. They will not burn or decay.

Jute woven in the form of burlap or canvas is used in some roofings to add strength. Its value is debatable. It is not a saturant like the felts and its fibers are not so thoroughly protected, making it liable on exposure to rot. Burlap decays much more readily than the average cotton felt.

The main use of tar for roofing has been in the construction of built-up roofs, where layers of felt saturated with tar are nailed down and by the use of a tar pitch protected and cemented together.

The following specification accompanied by the necessary diagrams give what is considered as good practice in the construction of a flat built-up roofing on wooden sheathing.

SPECIFICATION FOR FELT, PITCH AND GRAVEL OR SLAG ROOFING OVER BOARDS.

Incline.—This specification should not be used where roof incline exceeds three (3) in. to one foot. For steeper inclines modified specifications are required.

Specification.

Roofing.—First, lay one (1) thickness of sheathing paper, or unsatured felt, weighing not less than five (5) lbs. per hundred (100) sq. ft., lapping the sheets at least one (1) in.

Second, lay two (2) plies of tarred felt, weighing fourteen (14) to sixteen (16) lbs. per hundred (100) sq. ft., lapping each sheet seventeen (17) in. over the preceding one, and nail as often as is necessary to hold in place until remaining felt is laid.

Third, coat the entire surface uniformly with straight run coal tar pitch.

Fourth, lay three (3) plies of tarred felt, lapping each sheet twenty two (22) in. over the preceding one, mopping with pitch the full twenty-two (22) in. on each sheet, so that in no place shall felt touch felt. Such nailing as is necessary shall be done so that all nails will be covered by not less than two (2) plies of felt.

Fifth, spread over the entire surface a uniform coating of pitch, into which, while hot, imbed not less than four hundred (400) lbs. of gravel, or three hundred (300) lbs. of slag, to each one hundred (100) sq. ft. The gravel, or slag, shall be from one-quarter (¼) to five-eighths (⅝) in. in size, dry and free from dirt.

Flashing.—Flashings shall be constructed as shown in detailed drawings.

Labels.—All felt and pitch shall bear the manufacturer's label.

Inspection.—The roof may be inspected before the gravel or slag is applied by cutting a slit not less than three (3) ft. long at right angles to the way the felt is laid.

N. B.—To comply with the above specifications, the material necessary for each one hundred (100) sq. ft. of roof is approximately as follows: 100 sq. ft. sheathing paper, 80 to 90 lbs. tarred felt, 120 to 160 lbs. straight run coal tar pitch, 400 lbs. gravel, or 300 lbs. slag.

The built-up coal tar roofs have shown by many years' trial their value for protecting flat roofs. Instances where a life of from twenty to thirty years has been obtained are not at all rare, but poor results due to poor workmanship and poor materials are not new. The claim that at the present time the ordinary purchaser cannot be sure of getting coal tar of the quality of the best of that formerly produced would seem to have justification. At the same time, the oil tar may be no worse than the fluxes and residuals frequently used with competing materials. Pure coal tar and coal tar pitch are still made, and the dealers in roofing materials can, if they desire, furnish materials as good as any which have been sold in the past. Such materials, of course, are not the cheapest and where competition is severe the quality is liable to suffer. About all that can now be done to get the desired results is to be willing to pay the price and trust to the dealers.

The asbestos felt has advantage, due to its freedom from action of fire and decay, and it is claimed that the asbestos roofings have a considerable value in their blanketing influence on fires inside the building covered, which the ordinary felts do not have, points the value of which we consider have been overemphasized. The asbestos felt is not in any danger of being charred by hot asphalt, which sometime happens with rag felts.

The asbestos built-up roofings usually avoid the gravel or slag necessary with the ordinary "wool" felt built-up roofing. This freedom from the use of gravel or slag with its tendency to roll or be washed off the roof into the gutters is of some advantage. This also makes it easier to locate a leak and leaves the asbestos roofings much lighter in weight than the other types, an advantage which is probably to some extent offset by the insulating power of the much greater amounts of material used with the "wool" felt. As with all built-up asphalt roofings, difficulties encountered in the mopping make a slope of not more than three inches to the foot desirable.

At the same time the wearing qualities of the asbestos sheet is questioned. A coat of an asphalt paint is applied ordinarily.

Tar has not been successfully used with asbestos felts.

As compared with a five-ply tar and gravel roof, a four-ply asbestos roof will ordinarily cost at least from one to two dollars more a square. A three-ply roof is supposed to give good results over concrete, but for wood sheathing it would seem to be approaching too closely to the conditions met with in ready roofing, for first-class work.

This roof is ordinarily applied by the manufacturer.

PREPARED OR READY COMPOSITION ROOFINGS.

To compete with it and to meet some of the conditions where a built-up roof is not satisfactory or too expensive, innumerable prepared or ready roofings have been put on the market. These ordinarily come in rolls accompanied by the nails and cement necessary to apply them. They vary from a very light felt with the cheapest possible saturant and enough sand or soapstone coating to prevent sticking in the rolls, to a sheet so heavy that it cannot be rolled, built up of heavy felts and strengthening materials and saturated and protected by carefully prepared compounds, possibly protected also by a coating of crushed stone. The durability and fire-resisting value vary to as great a degree. Ordinarily the ready roofings are cheaper than other types, but some brands sell at prices considerably above the cost of a good built-up roof. To a certain extent the weight is designated by the ply, but there is no uniformity of practice among the different manufacturers. A two-ply roofing may mean a heavier weight than a one-ply, or it may mean two separate felts stuck together.

The saturant should be liquid enough at workable temperatures to thoroughly impregnate the felt. The protective coating should be stable and not easily affected by the elements. The saturation of the felt is a very vital feature. This must retain its life and elasticity to keep the roofing efficient. A protective coating of material similar to the saturation is often used with the idea of helping to maintain the life of the saturating material. In any event, the coating must be elastic like the saturated felt.

With a coal-tar roofing made to be rolled, it is impossible to use nearly as much material as is found necessary for a good built-up roofing, and such a roofing, even if made in the very best manner, cannot be expected to have a life comparable with that of a first-class built-up roof. Tar is not considered the best material for a high-grade ready roofing.

To successfully saturate with most asphalts, a felt much more open than that necessary for coal-tar must be used. Asphalt must be heated to a much higher degree than ordinary coal-tar to successfully saturate, and care must be taken to avoid charring the felt in the operation. Trinidad is but rarely, if at all, used for this purpose, it containing too much mineral matter and requiring too great a heat. California oil residuals are especially suitable for saturation purposes. At a temperature of 300 degrees Fahrenheit they are almost as limpid as water and at this temperature there would be no danger of charring the felt. They come between the so-called natural asphalts and coal-tar in their saturating properties and their susceptibility to changes in temperament.

The prepared roofings may be divided into two general classes—smooth and stone-surfaced. The stone-surfaced roofings are to a certain extent an adaptation of the built-up roofings. They frequently have at least two felts cements together. The gravel or slag used must be uniform in size and finer than that available for a built-up roof. The steeper the roof the more chance they have to lose their stone coating. The amount of material that can be used in the heavier brands is limited to the amount that can be successfully rolled. If the stone is too large, the stone may damage the felt in rolling; if too small, the amount of pitch is limited.

The smooth-surfaced roofings are usually coated with some finely divided material to prevent sticking in the roll. Tar is not suitable for their protective coating. The protective coating must be stable and not easily affected by changes in temperature. Blown oils are frequently used for this purpose. The smooth-surfaced roofings, as a general proposition, have less insulating and fire-resisting value than the heavier stone-surfaced materials, and with them a regular recoating or painting is frequently necessary in order to get satisfactory results. This point and the chances of getting the necessary regular attention should be considered in making selections.

Tarred felts in which there are two or three plies of felts cemented together with pitch are sold all ready to be laid. They must be covered with a tar coating upon laying and at frequent intervals to show any value at all.

The asbestos roofings are made to include one or more plies of asbestos felt, sometimes with a jute center. They are cemented together by asphaltic cements. In the heavier brands they are as expensive as a five-ply built-up tar and gravel roof. The asbestos felts are poor saturants. These roofings give promise of good results and are widely used. The asbestos will not burn, but the amount used is so small that its insulating value is not great, and the value of these roofings from the standpoint of fire protection is probably frequently overestimated..

Burlap or jute canvas is used in ready roofings as a strengthening material. It is not a good saturant and must be kept thoroughly coated, as otherwise it goes to pieces readily. It is employed in conjunction with either felts or asbestos sheets. We question its value, feeling that better results can be obtained from a proper quantity of ordinary felt.

The ready roofing is weak in that with the narrow lap and a large part of the roof covered with but one layer of material a single defect can cause a leak. The fact that on a flat roof water is liable to back up under the upper layer is a chance for trouble. Care should be taken that a nail is not driven into a crack in the roof sheathing, as the nail will work out, leaving a hole in the felt for entrance of water. The exposed nailing, where it is used, may rust out and can cause a tear or leak around the nail hole. This exposed nailing is avoided in various ways. Some of the manufacturers of stone-surfaced roofings finish the upper part of the sheet, which is to be covered by the next sheet, without any stone coating. The next layer is cemented on this strip. The only nailing necessary is thus done on the covered strip, where it is covered up by the sheet above.

The ready roofings usually commence to show deterioration after they have been kept in stock for three or four months. In purchasing care should be taken to avoid stock material.

The ready roofings are of value for small and isolated buildings where the cost of laying a built-up roof would be excessive and for temporary structures where a roof of long life is not necessary. They can be laid without the special workmen usually considered necessary for built-up roofing, but careful workmanship and skill are necessary to get good results.

TILE.

The term tile roofing is ordinarily considered as referring to roofing made of hard burned clay tile made with overlapping or interlocking edges.

These tiles have been used in Europe for many years. In recent years the advance here in the character and extent of the use of roofing tile has been marked and rapid. This material can now be had for prices much lower than those formerly prevailing. Tile has been placed on shops and factories which would under former conditions have been covered with slate or metal composition.

Originally the cost of tile was more than slate, but at the present time the price of ordinary patterns is about the same as for a good quality of slate.

The tile to be of value must be hard burned and have a durable glaze, well made. The ordinary unvitrified tile has a slip glaze which gives a dull red color, practically the color of the back, which is not glazed. This renders the outside of the tile practically waterproof so that it cannot absorb moisture and dirt. This sort of tile is all right in the South, where there is little chance of freezing of water absorbed through the back, but in the North its use is liable to be disastrous, and in order to get proper results a vitrified tile, which is homogeneous and does not require the slip glaze, should be used. The heavy green and brown glazes, either glossy or flat, are applied either to the soft or vitrified tile. These are applied in practically the same way as the slip glaze, by washing over the tile on the upper side before burning with a solution of the glazing material. With proper workmanship and materials, the glazes can be made so that they are durable and so that the tile will not crack or deteriorate under the influences of the atmosphere.

Besides the interlocking tile, clay shingles are made, which are laid like slate and give about the same results as slate.

With tile it is a little harder to get a tight roof than with slate. Tile should not be used on a roof having a less pitch than one-quarter, and a steeper roof is preferable. With them, as with slate, the less the chance for driving snow the flatter the allowable pitch, and for this reason in the South the use of tile can be more extensive than in the North.

Where there is a chance of driving snow, it is best to make a water-tight roof of prepared roofing, preferably a thirty-pound or heavier asphalt felt laid horizontally with well-lapped, cemented and nailed joints, as with slate. Sometimes the tile are imbedded in asphalt or coal tar pitch, but this method does not insure the best results. The waterproofing felt is better and cheaper.

It is usual to apply the tile directly over the asphalt roofing felt with heavy nails. They are sometimes fastened with cooper wires from a pierced lug toward the lower end of the tile. The wire is fastened to battens nailed horizontally on top of vertically laid battens or laths and fastened on by wire. Copper wire not less than No. 12 gage should be used for this purpose. Steel wire or bands corrode quickly.

Sometimes the tile are laid directly on steel or wooden purlins, which must be placed to suit the lengths of the tile, with the omission of roofing boards and felt. This construction is objectionable when the building is to be heated, but is suitable where escape of heat through the roof is desired or not objectionable and where an absolutely waterproof roof is not necessary. When so laid, to prevent the entrance of dust or dry snow, the joints may be pointed on the under side after laying with elastic cement.

Some manufacturers of roofing tile make glass tile of the same pattern as the clay tile, so that they may be worked in with them and used in place of skylights. These glass tiles have been used on the roofs of train sheds, shops and factories.

SLATE.

Slate comes with considerably varying qualities. It should be hard and tough and have a well-defined vein, which must not be too coarse. If too soft it will absorb moisture; if too brittle it cannot be cut and punched without splitting, and it will easily be damaged by walking on the roof. Crystals are sometimes found which disintegrate on exposure to the weather. Acid gases in the air and freezing of absorbed water tend to cause a disintegration of the slate.

The surface when freshly split should have a bright, metallic luster, be free from all loose flakes or dull surfaces, and be straight and true.

Most slates contain ribbons or seams which traverse the slate in approximately parallel directions. Slates containing soft ribbons are inferior and should not be used in good work. Hard ribbons do not necessarily indicate inferior wearing quality.

A clear, metallic ring when struck is an indication of soundness. A cracked slate gives a different sound, easily distinguishable. A soft slate gives a dull, muffled sound.

The color varies widely, but does not necessarily indicate the quality. Good, unfading black slate can be obtained. Some of the black slates fade rapidly on exposure to the atmosphere, assuming colors considerably varied. Various shades of green, red and gray may be purchased, some of which retain their original color very well.

Some slates are marked with bands or patches of a different color, and the dark purple slates often have large spots of light green upon them. These spots do not, as a rule, affect the durability of the slate.

Black ribbon slate may be obtained at less cost than strictly all black slate, and is suitable where slight variation in color is not objectionable.

Grading of Slates.

Some of the leading quarries grade slate as follows:

No. 1 Clear—A pure slate without any faults or blemishes, sold under certificate of guaranteed quality.

No. 2 Clear—A slate without "ribbons," made from rough beds.

No. 1 Ribbon—As well made as No. 1 clear, except that it contains one or more "ribbons" (black bands or streaks across the slate), which, however, are high enough on the slate to be covered when laid, thus presenting a No. 1 roof.

No. 2 Ribbon—This contains several "ribbons," some of which cannot be covered when laid.

Hard Beds—A clear slate, not quite as smooth as No. 1 clear, but much better than a No. 2 clear.

Slates were formerly punched for nailholes on the job only. Now,

however, slates are bored and countersunk at the quarry and should be so specified, as punching damages the slates.

Slate should not be laid on a roof having less than one-quarter pitch. Where the roof is flatter than one-quarter pitch, it is liable to leak from capillary attraction. Finely powdered snow driven under the slate by a high wind, later on melting and freezing, is liable to cause damage to a roof.

The best practice is to lay slate on wooden sheathing, tongued and grooved to an even thickness, and covered with a waterproof paper or felt to act as a bed and as an insulating medium. Tarred products should not be used, but a felt saturated with asphalt and weighing thirty pounds or more is preferable.

The use of an elastic roofing cement, ordinarily made up of refuse lead paint and paint skins, for bedding the courses next to gutters, valleys and hips is quite common on first-class work. This gives an even bed near the bottom and top of the roof.

CEMENT ROOFINGS.

Reinforced concrete tile, several square feet in area, have been used to a considerable extent on shop buildings and freight houses with steel roof trusses. They are usually formed with projections, so that they can be placed directly on the purlins and held in place by their own weight, without additional fastenings. Wire glass can be successfully inserted in these tiles, thus avoiding expensive skylight construction. Their cost compares favorably with that of slate. The reports from them are good; but, unless the roof framing is stable and even, there would seem to be danger of leaks from driving rain and snow.

Small cement tile are in use to a limited extent and the criticism given concerning the reinforced tile also applies to them. They are less expensive than clay tile, but are more absorbent and brittle. Improved methods of manufacture and further tests may later develop their merits for some purposes, but no economy has so far been shown by their use.

Asbestos sheets made of Portland cement and asbestos under pressure give promise of good results. They can be made in different colors and have some desirable features. The different manufacturers use different methods and the results obtained must be used with caution, as it is claimed that the methods of manufacture have an important bearing on the results which may be expected. Shingles of this type are said to have been successfully used abroad for many years. Recent changes are said to have much improved the quality of the material.

For small buildings, or where the design is such as to make tile undesirable, they have especial advantages. Their cost is somewhat greater than good slate, but their uniformity is such that they can more successfully be laid French or diagonal method than can slate. A considerable saving can be made by laying them French method, but we do not consider this good practice with large sheets (see diagram). The material is somewhat brittle, and with this method considerably greater amounts of breakage are to be expected, especially on the points.

When new, some water may be absorbed, but as they grow older this defect tends to disappear.

The corrugated sheets should have value as a substitute for corrugated iron sheets. They must be laid with good fastenings and sufficient lap to insure against leakage. Some of these materials are strengthened by wire mesh and some with perforated steel sheets, giving a product grading toward the metal protected by asphalt and asbestos.

SHINGLES.

A wood shingle roof, properly laid and of good material, will last many years. The old clear white pine shingles, formerly obtainable, were superior to anything now on the market, but red cedar shingles of good quality can be obtained from the Pacific coast. In the South red cypress from the Gulf States is preferable.

Dipping in linseed oil or creosote will add considerably to the life of the shingles. Creosote stains, which may be had in various colors, also add considerably to the looks of the building. They fade, but the roof can be gone over at intervals, if desired. Stained shingles are especially adaptable to small buildings, such as suburban stations, where appearance plays an important part and where it is desired to keep down expense. To get the best results the shingles should be dipped about ten inches, one by one, and allowed to dry before being used. This requires a good deal of handling and is for that reason expensive. A good deal of the stain will come off in the handling, making its use somewhat disagreeable for the workmen. Staining after laying is cheaper and gives an appearance about as good as the dipping, but does not materially increase the life of the roof, as the stain is not back under the joint. The application of a brush coat of stain to dipped shingles after laying makes the color more uniform and lasting. Painting after laying without dipping induces decay and should be avoided.

The main objection to a shingle roof is its fire hazard. When the roof is old, especially in a dry climate, shingles crack and get out of shape, providing a place for the lodgment of sparks and materially increasing the danger from fire hazard.

METALLIC ROOFINGS.

Metallic roofings may be laid in large sheets sometimes without any sheathing. These sheets are often strengthened by corrugating them. They are sometimes cut up into small sheets and laid as are shingles. Sometimes they are bent into interlocking shapes like clay tiles. The first cost of these tiles (except those of copper) is much less than that of clay tiles and they do not require as heavy roof-framing.

They are also soldered together on the roof into a single structure, of which the ordinary tin roof is typical. Copper, lead, Monel metal and tin are used this way. This type is especially valuable for flat roofs.

IRON OR STEEL.

Iron or steel are largely used as a basis for metallic roofings because of their strength and cheapness.

Their corrosion, especially for railroad buildings, is the most important factor in connection with their use as roofing materials.

This question of the corrosion of iron and steel is a live one, but the following conclusions seem to be accepted by the best authorities:

The rate of corrosion depends much less upon the amount of impurities present than upon their distribution in the metal. Segregation, strain, or anything which causes differences in electric potential, hastens corrosion. Mill scale is a very important factor, causing pitting. The better results often obtained from wrought iron as compared with steel are due mainly to the greater homogeneity of the iron. Good wrought iron is not appreciably better than good homogeneous steel.

There are some elements like sulphur which, when present in steel, tend to hasten corrosion and some, like copper, nickel and silicon, tend to retard it.

An absolutely pure iron in use on a building would not show results appreciably different from a high-grade steel, and with mill scale or internal strain might do much worse.

Iron or steel may be used unprotected except by paint. This, of course, requires regular attention and unless access can be had to all the exposed metal satisfactory results cannot be had. Galvanizing, or coating with zinc, if properly done, gives excellent results.

There are also on the market lead-covered steel sheets coated by special processes, some of which have shown up very well in comparative corrosion tests. Their cost is but little more than that of ordinary galvanized sheets and they seem to have considerable value. They can be painted better than galvanized iron.

Tinplate.

When tin is specified, the coating should consist of not less than 30 per cent pure tin, nor more than 70 per cent pure lead. Not less than 20 pounds of the coating should be used per box of 112 sheets 14 inches by 20 inches.

A great deal of very poor coating has been put on the market by the manufacturers of tin roofing material.

Good tinplate for roofing can still be had, and where it is desired to use this material for roof covering one of the reliable brands of hand-dipped plate, not less than IX or No. 28 gage, should be selected. Rolled tinplate should not be used for roofing, guttering or valleys.

Tin roofing must be painted, and with a good paint, to preserve it. Tin roofings can be shown which have lasted twenty or thirty years on railroad structures, but the danger of securing poor material and the cost of maintenance have made conservative builders very cautious in its use. It has the great advantage of being valuable for all slopes and it is adaptable to special and difficult conditions.

Sheet Lead.—Sheet lead has been used abroad considerably. Its main value is due to its immunity from action by acid gases, but it is expensive. It has a tendency to cold flow from its own weight, and it expands rapidly under heat.

Copper.—Good copper is not easily corroded, but it has a high rate of expansion and is expensive. It is not always possible to secure it of good quality, and, impure, it corrodes rapidly. It is only desirable for railroad buildings in rare cases.

Copper and Nickel Alloy.—For expensive building a natural alloy of copper and nickel, called Monel metal, is sometimes used, which works much like sheet copper, but is harder. It is said to corrode very slowly. Zinc-sheet zinc is used for replacing tinplate.

Methods of Application.

Sheathing.—Wooden sheathing improperly laid has caused the value of many good roofings to be underestimated. Green lumber should be avoided, as it will shrink in drying, with a resultant distortion of the covering material. With a prepared roofing, the felt will be given a wavelike appearance and the seams or joints forced open. With a slate roof the slate will be liable to be broken or loosened. Tin or copper coverings may be subjected to open seams and on a tile roof the shoulders in an interlocking type will be broken off. Sheathing boards should be surfaced to a uniform thickness, and ordinarily a plain board will be satisfactory. The sheathing should be thick enough to prevent the roofing nail from going through it. On some types of buildings the building should be stiffened by running the sheathing diagonally to the rafters and purlins.

In laying ready roofing on green sheathing, trouble can often be avoided by laying the roofing parallel to the sheathing, thus avoiding

the tearing out of the nails on each side of a crack by shrinking or warping of the sheathing.

Nails.—The life of many roofs is frequently dependent upon the nails and their selection is an important matter.

Gutters.

Gutters for many classes of railway buildings may and should be omitted. This is more particularly true of buildings with steep roofs near tracks where cinders from passing locomotives roll down the roof into the gutters, and in time, unless more care is taken to keep them clean than is usual in railway buildings, the downspouts become choked and fail to carry off the water.

Gutters may be of metal, wood, or be formed in roof of the materials used in the construction of the roof, the latter being ordinarily preferable where the design of the building permits.

Wood gutters are usually of Ogee form on the outside, and owing to the thickness of shell the capacity is small for the size of the gutters. They are made in three sizes, 3x4, 4x5 and 4x6. The capacity of these sizes is, however, scarcely more than one-fourth the same size of metal gutters of equal outside dimensions. They are the most durable kind of gutters for buildings exposed to smoke and cinders. They are usually made of fir, white pine or cypress, and should be painted inside and out every few years.

Metal gutters are made of copper, galvanized steel, iron, tin or zinc. For permanent buildings copper is preferable. All joints should be soldered and riveted with not less than four rivets for smaller sizes and should be well braced at least every four feet and proportionately increased in number of larger sizes. Cast-iron gutters are used to a limited extent.

Gutters may be built in the roof, or hanging, as the design of the building requires. Hanging gutters, which are easier to repair, and which do not damage the building if defective, are generally preferable. They should be given as much slope as practicable to the various downspouts and the outer edge of hanging gutters should be low enough to avoid chance of damage by possible backing up of water due to stopped-up gutters and conductor pipes.

Copper and galvanized iron or zinc must not come in contact on a roof, as rapid corrosion due to galvanic action takes place.

Flashing.

A large part of the trouble with roofing comes from leaks due to poor flashing around the edges, at gutters, parapet walls, and openings. Provision must be made for expansion and contraction, due to heat and cold, to loading and settlement and to shrinkage. It must be used far enough back to prevent any possible backing up of water. It is advisable to use as little metal as possible.

Special care must be used in working up against parapet walls, as with two kinds of material this is difficult. Special terra cotta block to insert in the parapet wall and give a point of application for the roofing material is on the market. It is valuable and would be more used were it not for the trouble in getting this special material on the ground unbroken and in getting it properly set in the wall.

Conclusion.

The Committee recommends the substitution for the last conclusion in the Manual under roofing (reading as follows: "Steel or impure iron materials should be avoided no matter how protected") of the following:

The various metallic roofings have an important place among the roofing materials. Care must be taken to have them properly used and protected.

In using iron or steel for roofing purposes every effort should be made to get a metal of best quality.

The roofings using Portland cement, either with reinforced concrete or with asbestos, have value under the proper conditions.

Discussion.

Maurice Coburn (Vandalia R. R.): The Committee asks that the report on freight house floors be adopted and printed in the Manual.

The report on this subject was accepted. The rest of the report was accepted without discussion.

WATER SERVICE.

Robert Ferriday, *Chairman;* J. L. Campbell, *Vice-Chairman;* H. M. Church, C. C. Cook, G. M. Davidson, A. F. Dorley, E. G. Lane, Curtiss Millard, A. Mordecai, W. A. Parker, Chas. E. Thomas.

The Board of Direction assigned the following subjects to your Committee:

(1) Report on the design and relative economy of track pans from an operating standpoint.
(2) Report on the design of water stations using deep well pumps as source of supply.
(3) Report on recent developments in pumping machinery.

The subjects in the hands of your Committee stand as follows:

REVISION OF THE MANUAL.

No changes to recommend.

(1) THE DESIGN AND RELATIVE ECONOMY OF TRACK PANS FROM AN OPERATING STANDPOINT.

The Committee asks for further time in which to make a final report on this subject. As a matter of information, the Committee presents herewith a valuable paper on "Track Tanks," by Mr. Geo. W. Vaughan, Engineer Maintenance of Way, New York Central & Hudson River Railroad.

(2) DESIGN OF WATER STATIONS USING DEEP WELL PUMPS AS SOURCE OF SUPPLY.

Your Committee felt that a study of deep well pumps would cover the vital subject in the design of deep well pumping stations and submits a report which outlines the various types of deep well pumps and the conditions favorable to their use. Your Committee believes that most of the members are familiar with the ordinary single-stroke steam deep well pumps, but are not acquainted with other types and with conditions essential to satisfactory operation. It was desired to submit data on efficiency, but this was found lacking. It may be possible that tests and further report can be made later. The report will serve, however, to inform the Association in a general way and probably to insure against improper installations, and it is hereinafter submitted as information.

(3) REPORT ON RECENT DEVELOPMENTS IN PUMPING MACHINERY.

Report progress. The subjects under consideration are: Internal combustion engines, centrifugal pumps and turbines and the use of electric power for water stations. The latter subject is thought timely in view of the availability of that power which is rapidly spreading through the construction of interurban roads paralleling steam roads.

(4) WATER TREATMENT.

Report progress. A study is being made of water softeners from an operating standpoint.

DEEP WELL PUMPS.

In this report a "deep well" is assumed to be a well usually of small diameter, in which the water does not stand within economical suction limits of the ordinary surface pump, or one in which the "drop" or "draft" with the desired yield brings the surface of the well water beyond an economical reach. This condition makes necessary the separation of the water end and the power end of the ordinary pump, the former being depressed into the well either to a point of submergence or within easy suction reach of the water during all its stages and the latter being placed on the surface of the ground within easy access of the boiler or other source of power. This arrangement has given rise to various devices known as "Deep Well Pumps."

Deep well pumps are of many varieties, but without attempting to include the many special devices for lifting deep ground water, those generally used with success in railway practice can be classified under the following heads:

(1) Reciprocating, displacement or plunger pumps.
(2) Centrifugal pumps.
(3) Propeller pumps.
(4) Air lifts.
(5) Air displacement pumps.

Reciprocating, Displacement or Plunger Pumps.

The old-fashioned domestic, or yard pump, is one of the first class. In this type the working barrel or cylinder is depressed in the well, either to a point of submergence, or within easy suction reach of the water, and the piston is connected with a power head located on the surface of the ground by means of a set of jointed rods of convenient length. The source of power may be either steam applied directly to the upper end of the rod, as in a direct acting steam head, or a geared or belted power working head may be used.

This type of pump may have either a single-acting working barrel, in which water is discharged on the upstroke only of the piston; or double-acting, in which there are two pistons, one above the other in the same cylinder, operated by separate rods, working in opposite directions. One of the rods is a pipe and the other an inside solid rod. The inside rod is connected to the lower piston and the hollow rod to the upper.

There is also on the market a double-acting type of displacement plunger pump having a single rod and a system of valves in the barrel so designed that water is discharged on both the upstroke and the downstroke of the plunger.

Of the double-acting pumps operated by double rods there are two types. In the first, the two plungers come to rest at the same time, one at the upper and the other at the lower end of the stroke, which results in an intermittent flow. The other type, called "constant flow" or "non-pulsating" pumps, are operated on the same principle as the quick-return mechanism used on shop machinery. About 53 per cent of the revolution of each plunger is spent in the upstroke and about 47 per cent on the downstroke. The plungers therefore come up more slowly than they go down, with the result that the first plunger has completed its downstroke and has picked up the load before the other plunger has come to rest at the end of the upstroke. In other words, one plunger is always lifting, and the column of water which does not come to rest as in the ordinary type of plunger pump has a constant and practically uniform flow.

Centrifugal Pumps.

There has recently come into use a vertical shaft, high speed, centrifugal pump of a diameter small enough to be lowered into a well of small bore to a point of submergence or within suction reach

of the water in the well. The pump can be operated by a direct connected electric motor, steam turbine or with a belt drive having a quarter twist. The last arrangement will be found less desirable than the other two, as it is rather cumbersome for a permanent railway installation. Either single stage centrifugals, or multiple stage, where the lift makes it necessary, are suitable for the purpose. They are usually made for pumping water from wells whose diameter to the water level is twelve inches or larger, and a flexible connection between motor and vertical shaft is generally used.

Propeller Pumps.

In this device, which is a modification of the old screw-pump, the power head is attached direct to the well casing and carries a vertical shaft that extends to a point of submergence in the well, both before and during the pumping. Propellers are placed on the shaft at regular intervals of about five feet. One propeller at least must be always submerged. Each propeller is usually provided with a stationary surrounding shield that protects the well casing against injury from the rapidly revolving propeller and also serves to center the shafting. The shields are usually riveted to several flat vertical spacing bars which form a caging to enclose the shaft and propellers.

Either a direct-connected vertical motor with a flexible coupling is attached to the power head as illustrated in outline in Fig. 3, or a yoke is provided to receive a pulley attached directly to the shafting. In the latter case, the pump is operated by a quarter-twist belt from a steam engine or other source of power.

This pump was first designed to discharge the water at the surface of the ground only, but there has recently been developed a combined turbine and propeller pump that will discharge against pressure, or, in other words, lift water above the level of the power head. The turbine is placed in alignment with the power head and propeller sections and the whole forms a concentric unit that will discharge water to the desired height above the pump head.

Air Lifts.

Opinions as to the true theory of the air lift differ widely, but it is generally accepted that its principle is that of a column of intermingled air and water in a vertical discharge pipe being lighter than the outside column of ground water, giving rise to a lack of equilibrium in the well, and resulting in the mixed air and water rising in the discharge pipe and overflowing at the top. The air lift consists essentially of a discharge pipe, of which the well casing may or may not form a part and an air pipe which leads the compressed air into the bottom of the discharge pipe.

The diameter of the air and discharge pipes must be properly related to the quantity of water to be delivered in order to avoid undue resistance and loss of efficiency. A discharge pipe with a sectional area so large that the velocity of the water exclusive of the entrained air falls below four feet seems to permit the air to escape through the water with great loss of efficiency, while a discharge pipe of so limited area that velocities over six feet are attained also causes decreased efficiency, probably due, at least in part, to friction resistances.

In Turneaure & Russell's "Public Water Supplies" the formula given as "commonly used for determining the relation of the various factors in an air lift problem" is—

$$q = \frac{125\ A}{h}$$

in which q = gallons of water per minute.
A = cubic feet of free air per minute.
h = height of lift in feet from water surface to point of discharge.

Air Displacement Pumps.

In this device for raising ground water the air acts as a piston upon the upper surface of the water in a discharge chamber, depressing it to a given level and discharging it through an eduction pipe to the desired point. In wells of small bore the discharge chamber consists of a vertical pipe or barrel to which is connected the air pipe at the upper end and the discharge pipe at the lower end as illustrated in outline in Fig. 6. The discharge chamber fills either by gravity or by suction. The air is admitted by a reversing valve that is actuated either by trip valves located in the discharge chamber, which in turn are operated by floats when the water has reached a predetermined level; or by the increase and decrease of pressure in the air line due to the rise and depression of the water surface in the discharge chamber.

Conditions Governing Selection of Type and Efficiency.

It is beyond question that all the devices for raising deep ground water described have their particular field of usefulness. The intermittent flow plunger pumps undoubtedly have a low efficiency. In both the single and double-acting types the column of water in the vertical discharge pipe comes to rest at the end of each stroke. The shock of overcoming the inertia of the column of water at the beginning of every stroke is necessarily violent and leads to great loss of power. The speed is limited to about 100 feet of piston travel per minute to prevent undue injury to the mechanism, and this limits the yield of the well to the actual displacement capacity of the pump at this speed. In the "constant flow" or "non-pulsating" type much higher speeds are practicable and the loss of efficiency due to the violent shock of stopping and starting the column of water is largely overcome.

Where the desired output is small and the lift is relatively low, the reciprocating pump undoubtedly has a wide field of usefulness. The first cost of installation is relatively small and the interest and depreciation charges are therefore correspondingly low. At water stations having a small output the fuel consumption, which is the factor most influenced by low efficiency, is a small part of the total cost of operation; the greater part of the operating cost usually represents the attendance and the interest and depreciation charges. However, this pump is simple and reliable and is giving good results where the yield per well or the desired quantity is small. The output can be increased approximately 100 per cent by the use of the double-acting type as compared with the single-acting, with some increase in first cost. High efficiencies are shown by the "non-pulsating" type and an increased yield is obtained on account of the higher practicable speeds. A test made by the Engineering Experiment Station at the University of Illinois with a motor-driven pump of the "non-pulsating" type showed an overall efficiency for motor and pump of 47.7 to 49.2 per cent. Subsequent experiments indicated that the efficiency of the motor was about 70 per cent and the pump efficiency was therefore also about 70 per cent, which is unusually high.

The reciprocating plunger pump does not lend itself well for operating scattered wells unless electric power is available. The maintenance of separate steam plants is impracticable, and where the character of the water-bearing formation requires a wide spacing of wells for good results the loss in steam transmission is necessarily large. Such wells, however, may be located in a straight line and be operated from a single shaft or may be located at random and operated by the device familiar in oil-producing territory, a description of such plant for a water station being given in the 1911 Proceedings.

Where the yield per well is large and large quantities are desired at a constant rate, pumps of the centrifugal and propeller types offer particular advantages. Units of this type are simple and compact, and their output is perhaps larger than that of any other device for raising deep ground water except the air lift. Relatively high efficiencies result where the type and design selected are made to fit the quantity of discharge, lift and other conditions of service. Where electricity is available scattered pumps of this type can be operated by individual motors at a minimum expense for supervision. This pump also possesses the particular advantage of successfully handling waters that contain considerable sand which in the reciprocating pump will soon destroy the wearing parts of the working barrel, but its use in wells that are not straight is not successful on account of the necessary bending and distortion of the shaft with every revolution. The maximum practical length of vertical shaft does not usually exceed 200 feet.

Air Lift and Air Displacement Pumps.

The air lift is not an efficient device, but it is capable of raising a larger amount of water from a small hole than any other deep well pumping method. The comparatively poor method of power application and many energy transformations can only result in limited efficiencies. However, it lends itself very well to serve scattered wells from one central power station, provided the spacing of wells is not so large as to result in excessive cost for piping the air supply. Its principal objections are the low efficiency and the disadvantage of providing the necessary submergence for best results, which under certain conditions is impracticable. The efficiency falls off so rapidly with a submergence decreasing below 60 per cent that any wide departure from this submergence renders the loss of energy practically prohibitive. In the air displacement pump a fixed submergence for good results is not required, as it is only necessary to have the discharge chamber sufficiently submerged to insure its filling by gravity or by suction.

The air lift offers particular advantages in handling wells that contain considerable sand, as there are no valves to be affected, also in operating wells that are so crooked that the ordinary pump rod or vertical shaft cannot be used and in holes of too small bore for other methods, but unless the wells are located in the immediate vicinity of the tank a second pump is necessary to elevate the water into the tank, as the air lift will not convey water horizontally, which, however, is true only of the air lift and not the air displacement pump.

Conclusion—Appendix "A," Track Tanks.

Track tanks should, preferably, be located on tangents and where good drainage can be provided, also where good water is abundant, and at sufficient distances from stations and all other facilities which would prevent trains from attaining a speed of at least 25 miles per hour. Modern power equipment is capable of hauling an enormous tonnage, and the tendency is to still further increase the size and capacity of locomotives. Therefore, in order to avoid the necessity of unreasonably increasing the water tank capacity of engines, the distance between trough stations should not exceed 40 miles, unless other controlling conditions require it.

The design of the power plant required cannot be outlined in detail for standardization, because this depends much on local condi-

tions. Boiler capacity of 100 horsepower will, in general, heat about 7,000 square feet of water surface in troughs, by means of direct heating system, sufficiently to prevent the water from freezing during the most severe weather encountered on the New York Central Lines. Accordingly, four standard troughs, as recommended, would require about 220 horsepower of boiler capacity for heating purposes.

Duplicate pumps should be installed to insure continuous service. The capacity of each pump should, in general, be about double the average hourly consumption of the plant. A boiler capacity of from 40 to 80 horsepower will be required for pumping. Pumping may be dispensed with when a good supply of water can be obtained by gravity. Sometimes the water is obtained from deep wells and can be most advantageously elevated into the storage tanks by means of the air lift, compressors in this case replacing the pumps. Usually water from deep wells is comparatively warm, so that, if scooping is frequent, very little heat is required to prevent freezing.

Some scoops are very inefficient, and it would seem reasonable to expect that the best could be improved. The design of the scoop used on the Lake Shore & Michigan Southern Railway appears to be the best of any used on the New York Central Lines. As pointed out above, any improvement in the efficiency of the scoop not only reduces the cost of operating the plant and the cost of maintaining the roadbed, but is equivalent to increasing the capacity of the track tanks. There also appears to be a greater opportunity to economize in this way than in any other in connection with the operation of troughs. It is, therefore, recommended that the design of the scoops be given further consideration.

Recommendations for Standard Practice.

(a) A trough 2,000 feet long, 7 inches deep, and having a width that will provide an inside clearance of 19 inches. It should consist of two standard 7-inch, 9.75-pound channels, with flanges turned in to form the sides and a flat plate ¼ inch thick and 23¼ inches wide, riveted to one flange of each channel, to form the bottom. This type of section is recommended because it is cheaper to construct, install and maintain than the customary type. The ties should be tapped 2¼ inches to receive the trough. This can be done safely and is sufficient to maintain the top edges of the trough below the top of the usual 100-pound rail, when the trough has become somewhat uneven, as it always does after it has been in service for a time.

(b) The end sections should be constructed with the bottom plate inclined at an angle so that the length of incline will be 10 feet. The plate should be ½ inch thick and secured to the side channels by angles riveted to each. The beginning of the incline where the scoop would first hit should be backed by an iron wedge and the balance backed by hardwood.

(c) The direct heating system is advised on account of it being less expensive to install and maintain, and being more efficient. The headway of trains is being considerably reduced in connection with the inauguration of automatic signals, requiring five inlets to each trough in order that it may be refilled quickly enough. Five inlets in connection with the circulatory system would render the cost of installation excessive.

(d) The drainage system, shown on plan entitled "Standard Track Tank; Drainage for Direct Heating System," is recommended, because it is effective in disposing of the spilled water and can be easily installed and maintained.

The report was accepted as information without discussion.

GRADING OF LUMBER.

Dr. H. von Schrenk, *Chairman;* B. A. Wood, *Vice-Chairman;* W. McC. Bond, D. Fairchild, R. Koehler, A. J. Neafie, W. H. Norris, J. J. Taylor, F. B. Walker.

Your Committee can report this year that the standard rules for maintenance of way lumber adopted last year by this Association, when submitted back to the lumber organizations interested, were agreed to, with slight modifications, as follows:

For southern yellow pine, by the Yellow Pine Manufacturers Association.

For hardwoods, by the Hardwood Manufacturers' Association of the United States.

For Douglas fir, by the West Coast Lumber Manufacturers' Association.

The Northern Pine Manufacturers' Association refused to accept the white pine rules. The acceptance of the rules adopted last year by the three associations referred to was made subject to slight modifications in the rules made since the time when these rules were first proposed. These modifications are so slight, however, that your Committee believes that they can be readily adjusted in individual cases.

Your Committee has been engaged in making further studies of rules for classes of lumber not included in the rules already adopted. These considerations are well under way, and it is expected two or three additional sets of rules will be ready for submission next year.

Consideration has also been given to the grading rules for cypress, submitted for information last year. (See Bulletin No. 144; Vol. 13, 1912, pp. 875-884.)

Recommendations.

Your Committee recommends that the lumber grading rules for cypress, as published in Appendix E, Bulletin No. 144 (Vol. 13, 1912, pp. 875-884), be adopted as standard.

The rules submitted as information last year on cypress were adopted for publication in the Manual.

ROADWAY.

W. M. Dawley, *Chairman;* J. A. Spielmann, *Vice-Chairman.*

Four Sub-Committees were formed to consider the subject assigned to your Committee.

(1) Present formulas of general application for determining waterway areas under varying conditions, including consideration of hydraulic features: W. D. Pence, Chairman; John C. Beye, A. C. Prime and W. C. Curd, Sub-Committee.

Considerable space has been given to the subject of waterway areas in the Association Bulletins and Proceedings in recent years and somewhat favorable action has been taken tending to support the general practice of using formulas as an aid to the judgment in such work. Successive reassignments of this subject for committee work has been made by the Board during the past two years and some further progress has been made. It does not appear, however, that data can be had at this time which would justify a further attempt to derive a simple formula having general application.

On the subject of the hydraulic features of culverts considerable information has been collected, but owing to incompleteness of certain features it is deemed advisable to defer the presentation till a later date in one of the Association Bulletins. Reference is again made to the valuable compilation relative to current practice in the determination of culvert areas in the Association Proceedings, Vol. 10, Part 2, for 1909, pp. 967-1022. In the discussions there given the hydraulic features receive considerable attention.

(2) Report on and recommend unit pressures allowable on roadbeds of different materials, conferring with Committee on Ballast: S. B. Fisher, Chairman; J. R. W. Ambrose, John G. Sullivan and C. S. Millard, Sub-Committee.

In Proceedings American Railway Engineering Association, Vol. 13 (1912), pp. 95 and 96, a list is given of articles published giving information and results of experiments made to determine the depth of ballast required to give a uniform distribution of pressure on the roadbed, the conclusion being that (with a tie spacing of 24 to 25.5 inches center to center) approximately 2 feet of ballast is necessary to obtain uniformity of pressure parallel with the track. In all these experiments there is no definite determination of the amount of this uniform pressure.

The Chairman of the Committee on Ballast advises that "the determination of the proper unit pressure with any degree of accuracy and without guesswork necessitates certain tests or experiments, and so far the Ballast Committee has not been able to find any information on this subject which has not already been given to the Association"; and your Committee on Roadway has failed to discover anything new on the bearing power of soils or on the magnitude of the unit pressures to be carried by the roadbed.

As the experiments should extend over a considerable period of time to cover seasonal variations and should be conducted under actual traffic conditions, the expense would be quite heavy and probably should be borne jointly by several of the larger railroad systems.

The present high percentage of rail failures together with the undoubted advent of the 100-ton car and the constant increase of locomotive axle loads make it imperative that some systematic study of the roadbed be made as a foundation for the track.

(3) Report on Tunnel Construction and Ventilation: Paul Didier, Chairman; W. P. Wiltsee, R. C. Falconer, F. L. Wheaton and Ward Crosby, Sub-Committee.

THE VENTILATION OF SUBWAY TUNNELS.

The ways in which subways have been ventilated may conveniently be considered under four separate heads:

(1) By introducing or exhausting air at various points by means of fans.

(2) By forcing a current of air from one end to the other of the whole line by fans.

(3) By so-called natural ventilation.

(4) By the piston action of trains.

Fans are almost invariably employed to exhaust air, not to supply it. They may exhaust through side chambers directly to the outside air, as in older portions of the Boston subway, or by means of air ducts communicating at various points, as in the Severn and Mersey tunnels. In the former case a number of comparatively small ventilating fans are employed at the points where the air is to be extracted; in the latter, large central pumping plants are used. In any case, fresh air is expected to enter at stations or other appropriate points as rapidly as the foul air is exhausted.

In the plenum principle the fresh air is forced in by the fans and the foul air escapes as best it can. This method is more often used to supply air during construction of deep subways than in subways after they are built. Many arguments have been brought forward to show the advantages of renewing the air at stations rather than elsewhere.

It has been urged, for example, that the air should be exhausted between stations and allowed to flow in at the stations since (a) more passengers are congregated at stations than at other points and in this way they will get the freshest air; (b) the air in the cars is renewed at stations and not between them, so the air should be at its best there; (c) this method would most rapidly remove smoke and heat in case of fire and give the best opportunity for escape through the stations.

Although many subways are now provided with some system of ventilation requiring the use of fans, by far the greatest number still depend for a circulation of air upon currents set up without special mechanical aid.

Among the more common ways of securing the so-called natural ventilation, the use of blowholes, or free openings to the outside air, deserve special notice. It is to ventilation accomplished in this way that the frequent renewal of air in the New York Subway is due.

The draught of air passing through the blowholes is sometimes violent. An average velocity of 16½ miles per hour through the stairways of the New York Subway was observed as a result of several hours' observation with anemometers. Had this current taken place through one-half of the openings between Ninety-sixth street and the Brooklyn bridge the quantity of air so supplied would have been capable of renewing the entire atmosphere of the subway every few minutes. At first sight it would appear that nothing could be easier than to ventilate a subway by this means. It seems as simple as opening the window of a living room. Yet to get the best effects from blowholes, ventilation means much more than the opening of the roof. To provide for a suitable and reliable movement of air requires careful study. Apparently the very simplicity of the idea of blowhole ventilation has prevented the development of this principle in the best manner. To some subways and tunnels it is peculiarly suited. The term blowhole is here used to include all openings through which the confined air can escape and fresh air enter, whether they be stairways, openings in the roof or openings through side chambers. In shallow subways such openings usually pierce the roof or lead from station platforms with more or less directness to the outside air. They are usually much too small, too indirect and too long to accomplish all the benefit which may be obtained from them.

Inasmuch as the flow of the air is impeded by friction against the walls, blowholes should be as short as practicable. Since the friction increases as the square of the velocity of the current and inversely as the diameter of the passage, they should be large in section and but little obstructed by screen, doorways, nettings and other incumbrances.

It is easy to see that blowholes may be more advantageously employed in subways built near the surface of the ground than in railways far beneath the surface. And yet this is the only way in which some of the deep London tubes are ventilated. If, as sometimes happens, the blowholes are open stairways covered by cowl-like kiosks, the direction of the openings with respect to prevailing breezes may materially aid or interfere with the amount of air which passes in or out. Let us briefly examine this effect.

A breeze which is just perceptible may be assumed to travel at a velocity of 2.92 feet per second and to exert a pressure of 0.02 pound per square foot, and a breeze of twice this velocity exercises four times this pressure. A brisk wind traveling at a velocity of 25 miles per hour, or 36 feet per second, a not uncommon occurrence in New York at some seasons of the year, exercises a pressure of about 3 pounds per square foot. A wind of 45 miles exercises a pressure of 10 pounds. If a pleasant breeze of 2½ miles per hour acts full upon a kiosk measuring 5½x7½ feet it is as effective as two fans, each 6 feet in diameter, turning at the rate of 200 revolutions per minute and delivering 21,200 cubic feet of air per minute.

The action of moving trains is more important than any other factor in establishing a circulation of air through blowholes. This so-called piston or plunger action has long been recognized as useful, but it has remained for the New York Subway to demonstrate how extremely beneficial it may be. The main principle of the phenomenon of piston action is easily understood. The moving trains force air ahead of them and cause air to rush in after they are passed. The quantity of air moved depends upon many circumstances. Chief of these are (a) the extent to which the tunnel section is filled by the section of the train; (b) the speed of the train; (c) the opportunity afforded by blowholes for the air to flow in and out; (d) the shape of the forward end of the train.

In studies made on the Berlin-Zossen Railway into the resistance offered by the free outside atmosphere to the movement of trains, it was found that air piled up in front of the first car in the form of a cone of increased pressure and that a cone of reduced pressure followed behind the train. For example, the pressure in front of a car (which presented a face perpendicular to the line of the track) was 4.09 pounds per square foot at a speed of 12.4 miles per hour; 6.14 pounds at 18.6 miles; 8.19 pounds at 24.8 miles. This pressure was maintained for between 10 and 16 feet in front of the moving train; beyond this it gradually fell off (Street Railway Journal, New York, October 28, 1905, p. 802).

Observations made in the New York Subway before any material changes were made in the arrangements for ventilation, with the ordinary train service of early afternoon, have shown that air passed from one station to another sometimes at a rate of over 8 miles per hour and at an average of about 3 miles. The approach of a train toward a station on the four-track road could be felt by the flow of air ahead of it while the train was over 1,000 feet away.

The exhaling and inhaling action due to the operation of trains is of peculiar value in that it occurs when and where most needed, provided, of course, that the openings to the outside air are properly placed and unencumbered. The greater the number of passengers carried and the greater the number of trains, the greater is the amount of ventilation. And not the least conspicuous of the advantages of so-called natural ventilation is its economy.

No expense is necessary for the operation of mechanical devices in natural ventilation. Experience with the New York Subway shows that it is not always necessary or desirable for a train to fit very closely into the tunnel section. In fact, it is conceivable that when this fit is close the cars carry along more of their own air than desirable and the passengers within them enjoy much less interchange than would take place otherwise.

Your Committee presents the foregoing as information, withholding conclusion until experiments now being conducted on single and double-track steam railroad tunnel ventilation are completed.

(4) Economics in Roadway Labor: H. J. Slifer, Chairman; J. A. Spielman, J. E. Willoughby, Frank Merritt, Sub-Committee.

Your Committee having agreed with the Track, Signals and Interlocking Committees on a subdivision of the work, reports progress.

Recommendations for 1913.

Your Committee recommends that subjects 2, 3 and 4 be reassigned, again respectfully calling attention to the resolution above referred to.

This report was accepted as information.

RECORDS AND ACCOUNTS.

H. J. Pfeifer, *Chairman;* M. C. Byers, *Vice-Chairman.*

The Board of Direction assigned the following work to your Committee for the current year:

(1) Make a comprehensive study of the forms in the Manual, which were adopted a number of years ago, and bring forms up to date.

(2) Continue the study of the economical management of store supplies.

(3) Recommend feasible and useful subdivisions of Interstate Commerce Commission Classification, Account No. 6, with a view to securing uniformity of labor casts.

The Sub-Committees were appointed by the Chairman after consultation with the Vice-Chairman, as follows:

Sub-Committee No. 1—Guy Scott, Henry Lehn, J. H. Milburn and Orlando K. Morgan.

Sub-Committee No. 2—J. M. Brown, G. J. Graves, E. E. Hanna, G. D. Hill and Edward Gray.

Sub-Committee No. 3—Frank Ringer, W. A. Christian, Walt. Dennis and C. W. Pifer.

After a conference with the Vice-Chairman of the Committee, and the approval of the Board of Direction, the Chairman on behalf of the Committee invited the Railway Storekeepers' Association to appoint a representative to co-operate with the Committee in the discussion of Subject No. 2. Mr. E. J. McVeigh, Storekeeper, Grand Trunk Ry., Ottawa, Can., Chairman of their Committee on Recommended Practice, was elected. He attended the Committee meetings at St. Louis and Chicago, and gave the Committee most valuable aid in reaching its conclusions.

Conclusions.

Subject No. 1.

Some of the forms, particularly those used in connection with the accounts, such as foremen's reports of labor and material consumed, might be changed in some particulars, but it is doubtful if such changes would bring about their more general use by the railroads, as little, if anything, would be gained by suggesting minor changes in these forms. It is the opinion of the Committee that no changes be made at the present time in the forms appearing in the Manual. It is suggested that since the selection of the proper forms for time books, foremen's material reports, distribution sheets and authorizations of expenditures is a matter in which the Accounting Department is as much interested as the Maintenance of Way Department, for the reason that these forms and reports are the foundation of the entire maintenance of way accounting structure, that it would be advisable for this Association to join with the American Railway Accounting Officers' Association in the development of a set of forms, to be recommended by each association, which would be generally adopted by railways.

Subject No. 2.

The Committee carefully discussed the report made last year with Mr. McVeigh, the representative sent by the Storekeepers' Association, and we believe that the conclusions which we have reached will meet with the approval of Mr. McVeigh, and that there is a strong probability that they will be approved by the Storekeepers' Association. Discussions were confined to the conclusions approved by the

Association at the annual meeting in 1912, which were under the following headings: (A) Standardization; (B) Classification of Material; (C) Stock Account; (D) Distribution; (E) Organization.

(A) Standardization.—No change is recommended for this heading.

(B) Classification of Material.—The Committee recommends that the details of classifications should conform to those adopted by the Railway Storekeepers' Association.

(C) Stock Account.—The conclusion reached last year is fundamental. The detailed methods of keeping the accounts may be varied to fit the individual condition. Stock accounts can be kept, first, by ledger account; second, by card system; and, third, by personal inspection and estimation.

(D) Distribution.—No change is recommended for this heading.

(E) Organization.—The essential elements are as follows:

(1) Location.—The store should be located as closely as possible to the point of greatest consumption so that the minimum force will be required, and that the delay to material between the store and its destination may be reduced to a minimum. Usually this is at a point where equipment is maintained.

(2) Force.—The force required is dependent almost entirely on the character and volume of material issued and on local conditions. As the prompt and efficient handling of material and tools has a vital effect on the economical operation and maintenance of the railway, the force in the storeroom should be large enough to bring about this result.

(3) Position in Organization.—The consumption of supplies being greatest in maintenance of way and equipment, the Storekeeper should be closely associated with the heads of these departments. It is the opinion of the Committee that this can best be accomplished by having the Storekeeper, Engineer Maintenance of Way and the Master Mechanic report to the same officer. In a divisional organization this would place the Division Storekeeper under the Superintendent and the General Storekeeper under the General Manager or Vice-President in charge of operation.

(4) Mechanical Equipment.—Cost of unloading, storing and loading material depends solely upon the volume of business done by each store, and such appliances as will reduce this cost to a minimum are recommended.

(5) Plan.—A typical layout of a store is herewith presented, which can be expanded or reduced as the situation demands.

Subject No. 3.

The Interstate Commerce Commission, in their Classification of Operating Expenses, which became effective July 1, 1907, included in the maintenance of way accounts primary Account No. 6—Roadway and Track. This account includes about one-third of the total charges for material and labor in the maintenance of way and structures accounts. This account includes practically all of the labor performed by section and extra gangs chargeable to the maintenance of way and structures operating expenses, and it seems desirable to provide subdivisions of this primary account in order to analyze operating expenses and assist in securing uniformity of labor costs.

A brief outline of the reasons for recommending the proposed sub-accounts is as follows:

Sub-Account A—Track Maintenance. Under this caption is included all labor necessary to maintain good line and surface of track, except for the application of material. In other words, if the material and drainage conditions are good, but the track is in poor line and surface, the labor necessary to place the track in good condition will be charged to this sub-account. Also, if it is necessary to temporarily reduce expenses, the available force should be used on line and surface work so far as possible.

Sub-Account B—Applying Track Materials. Applying Track Materials is subdivided into (B-1) Applying Ballast; (B-2) Applying Ties; (B-3) Applying Rails; (B-4) Applying Other Track Material.

These sub-accounts will furnish as much detail as is practicable for convenience in comparing labor costs.

Sub-Account C—Cutting Weeds and General Cleaning. This sub-account includes work which is less important than some of the other items, and the amount expended is largely dependent upon keeping the property in presentable condition rather than for reasons affecting safety or economy.

Sub-Account D—Ditching and Bank Widening. This sub-account includes the most important element in providing good track. Frequently the material removed from cuts is used in widening embankments, and therefore ditching and bank widening are logically included in the same sub-account.

Sub-Account E—Changing Alignment and Grades. Under this caption is included the operating expenses resulting from abandoning the present alignment on account of reduction of grades or curvature, and it is necessary to separate this from the other expenses which more directly affect the economical maintenance of the property.

Sub-Account F—Flood Damage. This sub-account includes the cost of repairing damage to the roadbed and track caused by unusual conditions, such as cloudbursts, floods, etc. It is necessary to separate this class of expenditures from the ordinary maintenance work in order that the latter may truly reflect the average expenses in maintaining the property. This sub-account also furnishes the basis for investigations to determine the amount which may be profitably expended to eliminate future damage.

Sub-Account G—Bank Protection. Under this caption is included expenses necessary to protect the roadbed and track from slides, washouts and other unusual damage to the property.

Sub-Account H—Filling. This sub-account provides for the expense of filling bridges.

Sub-Account I—Other Care of Roadway and Track. This sub-account is intended to include the cost of trackwalkers, watchmen and other expenses not specifically provided for in the other sub-accounts.

It is the opinion of your Committee that the subdivisions of the Interstate Commerce Commission Classification, Account No. 6, of Operating Expenses, will be of assistance in securing uniformity of labor costs, but in order to obtain the greatest efficiency and most economical results additional information must be obtained and action taken.

Some of the most important elements in securing uniformity of labor costs and efficiency in handling work are as follows:

(1) Adoption of proper method for doing the various kinds of work under usual conditions. Efficiency in the various kinds of work performed in the Maintenance of Way Department has received very little study up to the present time, and it is safe to say that practically the same methods are being followed today that have been in use for a great many years. As an illustration, there are probably as many methods employed by section foremen in putting in ties under the same conditions as there are foremen doing this work, and by making a careful study of the elements entering into each operation the best method employed by each foreman may be combined to produce an approved practice for the various items of work under the most usual conditions.

(2) Economical distribution of material so as to reduce the amount of labor necessary in applying.

(3) The selection of proper tools and their maintenance in good condition.

(4) Organization and supervision.

(5) The selection of the proper season of the year for performing the various kinds of work.

The report was accepted as information.

CONCLUDING BUSINESS.

George W. Kittredge (N. Y. C. & H. R. R. R.): I offer the following resolutions:

"*Resolved*, By the Members of the American Railway Engineering Association, That we hereby express our appreciation of the manner in which our retiring President, Charles S. Churchill, has discharged his duties as President during the year, and presided over the meetings of this convention; and be it further

"*Resolved*, That this resolution be spread upon the minutes and a copy furnished Mr. Churchill."

This motion was seconded by L. C. Fritch, and was adopted by unanimous consent.

Charles S. Churchill: I appreciate this action and have also greatly appreciated the honor of this position. I hope my successor will have great success, and I know he will, for this is one Association where the officers have the hearty support of every member. This organization has the respect and esteem of the whole United States. Gentlemen, I thank you.

Address of E. F. Wendt, President-Elect.

"I deeply appreciate the honor conferred upon me and will do my best to merit your confidence. The work of this Association, with your help, will be carried to a successful conclusion. We are to be congratulated on having such a Secretary as Mr. E. H. Fritch, and his careful work aids greatly in the things we accomplish.

"I think we are justified again in thanking the National Railway Appliances Association for the valuable exhibit which it prepared for us.

"We are also fortunate in having the technical press as a support to this Association, and we confidently expect them to continue their work to the benefit of our membership.

"The Committees are responsible for the tangible results which we accomplish and they deserve the greatest approbation of the membership.

"It is necessary that we secure more members if we accomplish all we wish in the future. The membership is now 1,115, but there are at least 1,500, and probably 2,000, who are eligible.

"The object of this Association is the advancement of the scientific knowledge of our profession, and if we temper theory with experience our work will greatly benefit ourselves and the railways of America.

"We must meet the new conditions brought about by the Hepburn Act, which has caused much disturbance of financial conditions in connection with our business.

"The valuation of the railways, which is becoming an important question, is a tremendous problem, and this Association should give the question consideration when the time comes. When the railways are intelligently valuated I think it will be discovered that the value of their properties far exceeds their capitalization.

"If there is no other business, the Fourteenth Annual Convention is now adjourned."

Special Committee Report on Concrete

ON ACCOUNT of limited space and in order not to give our readers too much of the same class of reading in one issue, we intend to cover in a number of issues extracts from the Special Committee Report on Concrete and Reinforced Concrete published in the February proceedings of the American Society of Civil Engineers.

These extracts will be from such parts of the report as are considered the most important and requiring special emphasis because of past and present practices which should be discouraged, or cited as good examples, as the case may be.

Keeping Reinforcement in Position While Concreting

THE HOLDING of reinforcing bars in proper position while concrete is being placed is a matter which merits the utmost attention. The labors of the best designer and detailer can be set at naught by the carelessness of those in charge of the construction of reinforced concrete structures, while placing steel and concrete.

A designer spends many days designing and detailing a complicated structure, the strength of which can be greatly impaired by comparatively slight displacement of the reinforcement at critical sections. Much time is spent in designing and detailing the reinforcement for a structure and the all-important matter of getting and keeping the bars in correct position is disposed of by a single note such as the following: "All reinforcement to be bent and placed as shown on plans and to be securely fastened or tied to prevent displacement during pouring of concrete and to insure proper position of reinforcement in the finished structure." It is left to the discretion of the construction foreman to devise a means of keeping the bars in position and as a result the strength of the structure may depend on whether the foreman thoroughly understands his business or not.

This is neither good practice nor economy. The method and means of supporting reinforcing bars should be clearly indicated on the plans, since they are as important details as the location of bends of bars and stirrups. Where bars are bent up into the tops of slabs and beams they are best supported by crossbars resting on concrete blocks of a height to insure the exact location of bars. Bars in the bottoms of slabs can be kept at the proper height by small Z-shaped clips and spacing bars, to which the main bars are wired.

It is just as important to show the supporting bars, supporting blocks and clips, and the spacing bars as it is to show the main reinforcement in detail. Before the structure can be built it is necessary for some one to devise a means for keeping bars in position during construction, and as a general rule a good designer is more capable of handling these details to good advantage than anyone else. If it is left to the contractor, the owners pay dearly for this "designing service" rendered by the contractor if he is wide awake; and if he is not, he pays the bill. It can be seen at once that this is neither fair nor economical, and is very likely to lead to "wild" and "unbalanced" bids.

If a contractor is to bid intelligently and all contractors are to enter their bids on the same basis, it is imperative that these details be shown on the plans when the work is at all complicated or important. The double purpose of keeping the bars in place and having more balanced and uniform bids is fulfilled at once by including these supporting details in the detail plans, and the practice should be encouraged and should be more in evidence than in the past.

Concrete Fence Posts and Fences for Railroads

ONE of the small uses in railroad work to which concrete is especially adapted is for fence posts and also concrete fences.

Concrete posts for wire right-of-way fences are of greater strength and more pleasing in appearance than wooden posts, and besides this they are not destroyed by fire and decay. Nowadays, with many kinds of patented and unpatented post molds on the market, good concrete posts can be made of a woven wire fence with concrete posts 20 ft. centers, built posts. The cost of a 7 ft. concrete post ranges from 15 to 25 cents depending on type and local conditions. The cost of a woven wire fence with concrete posts 20 ft. centers built by the Long Island R. R. was 10 cents per lineal foot. Concrete posts are heavy and therefor are especially adapted to swampy lands where there is a tendency for wooden posts to float and get out of line.

For fences on bridges and at stations, solid paneled concrete fences, or fences made up of concrete rails and spindles are attractive, the cost not exceeding greatly that of ornamental iron fences, and the maintenance costs of the former are very much less and they are also more permanent.

Railroads are using concrete fence posts in great numbers and the time will soon come when wooden fence posts will be used very little, especially in populous districts.

RECENT APPLICATIONS OF CONCRETE AND REINFORCED CONCRETE IN THE CITY OF PITTSBURGH.*

N. S. Sprague, M. Am. Soc. C. E.

This paper relates entirely to the application of reinforced concrete for bridge repairs and reconstruction, and is not so general in its scope as the title implies. The purpose is not to describe in detail the methods of design and construction of the large concrete bridges built or now being built by the city, but rather to call attention in a general way to some of the important features and problems which confront the engineer in the selection of the type of bridge best adapted to the site, traffic, funds available for the purpose and other conditions.

*Abstract of Paper read before the National Association of Cement Users at Pittsburgh Dec. 1912.

Since concrete reinforced with steel is now recognized by most engineers as a suitable material for the construction of bridges, it becomes the duty of the bridge engineer to weigh the relative merits of this material as compared with steel and to decide, after taking into consideration the other questions involved, which of these two materials is best suited for the work.

Economy and Problems of Design.

In the design of all the new Pittsburgh bridges, the amount of funds available for the building of each was limited, and it was necessary to exercise the strictest economy in their design and to sacrifice some of the artistic features. The Larimer Avenue bridge represents the highest type of economic development consistent with climatic conditions which obtain in this section of the country. The two ribbed arch for long spans has much in its favor with respect to economy of materials and simplification of design. It is true that the floor system for the twin arches must be heavier and the excess of materials used in its construction must be charged to the material saved by the omission of the middle rib and columns, but on the other hand there is a very decided reduction in the amount of forms required which is perhaps the most expensive item of construction. If the arch is made of three ribs the middle rib carries the greatest load and must be made larger than the outside ribs and this condition of unequal loading produces indeterminate temperature stresses, due to the variation in the size of the ribs, which tends to produce crecks in the floor system.

All these arches were designed disregarding the use of the rib reinforcement, which to some engineers may appear extravagant, but since the number of long span arches is small and of comparatively recent construction, the opportunity to observe their behavior under various conditions for a reasonable period has not been possible. Under these conditions the ribs were designed only for compressive stresses and the introduction of the steel in the ribs was simply to provide an additional factor of safety, more rigidity of the whole structure, and greater elasticity of the ribs.

One of the greatest practical difficulties in reinforced concrete construction of this nature is to secure the proper spacing of the steel rods and to prevent their displacement in the process of concreting. Large steel rods such as are required in massive structures are most difficult to bend and handle, and these difficulties have been overcome by the use of structural shapes in the arch ribs, which insure their correct location in the concrete and facilitates erection.

The economic problem in the design of concrete bridges, taken in conjunction with the planning of the proper artistic features, is most difficult to solve and often presents the attainment of the best architectural results to a full and reasonably desirable extent.

In making the plans for the large concrete bridges in Pittsburgh, the principal dimensions and general type of bridge were determined largely by the profile of the ground, and required certain forms of construction which could not be changed, however desirable it might be in order to give better lines to the structure. The architecture on some of these bridges, broadly speaking, was divided into two classes: first, the best architectural treatment possible to such parts of the bridge as were fixed by scientific principles of design or local conditions and which could not be changed; and second, those embellishments which add nothing to the strength, serve no useful purpose, but which add greatly to the beauty and grace of the structure. The first class adds little additional cost, but the second class will in general greatly increase the cost of the structure. Having satisfied the utilitarian requirements, many modifications are frequently required to produce an artistic looking structure. Theoretically the best manner of procedure is the adjustment of the type of bridge to the site under consideration. Graceful and pleasing lines can be adopted in all cases, even where the necessity for the strictest economy prevails. Where funds are available and where conditions make it desirable, strict conformance to architectural features and precepts are most commendable. If only the economic features of design were considered, ignoring the aesthetic entirely, this practice would result in one type of bridge, thereby subjecting the designer to criticism, on account of the similarity of the bridges and because of the neglect of excellent opportunities to give character, dignity and individuality to each of the structures.

Workmanship and Construction.

However carefully and accurately designed a concrete bridge may be, the work of the designer may be set at naught by delegating the construction to incompetent, inexperienced and unskillful contractors. A large bridge is an imposing and monumental structure, and therefor the engineer must require the same degree of excellence of workmanship and skillful management as the architect demands in the execution of his plans for some magnificent building. The problem of the engineer in this respect is much more difficult of attainment than for the architect, since on concrete bridge construction most of the work is performed by unskilled labor and with the use of materials difficult to handle. A large concrete bridge is composed of a number of large monolithic adequately brace the forms and preserve their true and correct alignment. The bulging of a form or the unnoticed escape of grout from the concrete are defects which may not impair the strength or ordinary construction and are easily remedied in most kinds of concrete work, but in bridge work these accidents are likely to result in ruining the appearance of the whole bridge.

Closely related to the importance of good workmanship on concrete bridges is the question of concrete surface finish. This may seem like a relatively unimportant matter to some engineers, and a detail which is unworthy of their serious considertion; this is undoubtedly true for some structures, but if the general use of concrete for bridges, buildings, towers, etc., is to continue, its future use for these structures will depend in no small measure upon the ability of the engineer to produce effects in the surface finish of the concrete which will compare favorably and furnish an equally good contrast with other kinds of building materials. This opens a large and profitable field for investigation and experiments along this line. The smooth concrete surface with its uniform color is lacking in character and individuality, which makes it desirable to roughen the surfaces and expose the stone in the concrete or else incorporate into the mass, materials other than those ordinarily used in its composition. It is probable that the ultimate solution of this most important question will be found in this manner, rather than by the application of external treatments. In some cases good results have been obtained by bush-hammering the concrete with a hammer, having about 11 points to the square inch. This method of finishing the concrete surface requires the use of broken stone aggregate instead of gravel and considerable skill on the part of the workmen to obtain a uniform finish and prevent chipping the corners.

(In the paper as read, descriptions of the various concrete bridges recently built by the city of Pittsburgh were given but these are omitted here since the largest of these were described in the article on Concrete Bridges and Viaducts in the January, 1913, issue of Railway Engineering.—*Editor.*

Relative Costs.

With respect to the relative difference in first cost between a concrete and steel bridge, most any conclusion can be reached, depending upon the assumptions made for the purposes of comparison. For example, let us assume that a steel arch bridge with masonry abutments and 50 ft. in width, could be built for $150,000.00 on the site of the Larimer Avenue bridge; it can also be assumed with equal propriety that a steel bridge of the cantilever type and of the same general dimensions would cost a somewhat smaller sum, and again, a steel bridge of the viaduct type could be built for much less than either of the others. For this reason the comparison should be made by selecting that type of steel bridge designed for the same loading and which compares favorably in appearance and in other respects to a concrete structure.

Let us assume that a concrete bridge can be built in a given location similar to the Larimer Avenue bridge for $170,000.00, and that a corresponding good steel structure can be built for $150,000.00, and the life of the steel bridge with proper maintenance is 50 years, and make a comparison on this basis.

For a steel bridge the—

Annual charge for repainting, assuming the bridge is repainted once in five years at a cost of $5,000.00	$1,000.00
Annual charge for repairs 5 per cent of the first cost of bridge	750.00
Annual interest charge at 4 per cent on the investment	6,000.00
Annual sinking fund for renewal at end of 50 years at 4 per cent	982.50
Total annual charge for steel bridge	$8,732.50

Now if the concrete bridge cost $170,000.00 or $20,000.00 more than the steel structure, the only charge which can be properly made against a bridge of this type is the interest on the first cost of the investment, computed at 4 per cent which would amount to an annual charge of $6,800.00. Assuming that this reasoning is correct it appears that an expenditure of $218,300.00 would be warranted for the building of a concrete bridge, as against $150,000.00 for a steel structure.

In the above comparison it is assumed that both bridges would have the same amount of repairs to the roadway, and this item is therefore neglected. In addition to the financial advantage of the concrete bridge over one built of steel, there is the aesthetic difference between the two types for which no numerical value can be assigned, but which nevertheless is an important element of the comparison.

The Durability of Reinforced Concrete Bridges.

The use of concrete as a building material dates back to the time of the Romans, but its use in conjunction with steel is of comparatively recent origin and hence the opportunity for study and research to determine the effect upon the concrete and steel reinforcement of those forces which would naturally tend to destroy and shorten the life of the structure has not been possible. Since the advent of reinforced concrete, many instances are recorded where structures built of this material have been changed or altered and which furnished at the same time, an opportunity to observe the condition of the steel reinforcement. In connection with recent repairs to the Smithfield Street bridge, some concrete was removed from the end posts of this bridge which had been in place for twenty-two years and used for protective purposes. A careful examination of the steel showed no indications of corrosion and it was apparently in as good a state of preservation as when erected. From such observation, tests and experiences, it is proved that concrete furnishes a good protection to steel against corrosion, but the steel may be subject to the destructive influence of electrolysis. The danger of electrolysis in the case of a bridge could easily be avoided in the design by properly grounding the steel reinforcement.

Many engineers have been heard to give expression to the thought that reinforced concrete structures will endure forever. This statement may be true of certain structures which are removed from and not subjected to the action of the elements or do not have to resist the forces produced by impact, but a concrete bridge is not so fortunate in this respect. They are necessarily exposed to the elements, subjected to great variations of temperature incident to this climate, and must withstand the shocks and jars of large and heavy street cars. Should cracks develop in the bridge (and they are not uncommon however carefully the bridge is designed) which permit the entrance of snow and water the effect of continued freezing and thawing upon the concrete, year after year, and the possible corrosion of the steel reinforcement is difficult to foretell. In any event, they are factors which should be considered as intimately related to the life and durability of long span concrete bridges.

As an evidence of the durability and economy of concrete bridges, it is a significant fact that many of the large railroad systems of this country and also a number of the state highway commissions have generally adopted the use of concrete for bridge construction instead of steel, where practicable. Such failures of concrete bridges as have already been recorded were due to improper foundations, and faculty design or construction rather than to any inherent weakness or disintegration of the materials themselves.

The use of concrete for bridge construction has passed the experimental stage. Furthermore, its use for such purpose has been satisfactorily demonstrated and the results derived therefrom are sufficient to justify the engineer in the belief that the life of concrete bridges will at least equal and probably exceed that of a steel structures, with a very substantial saving in the cost of maintenance.

New Books

THE THEORY AND PRACTICE OF TECHNICAL WRITING. By Samuel C. Earle, 6x9, cloth, 301 pages, illustrated. Published by The Macmillan Co., New York. Price, $1.25.

Books treating of the fundamental problems of technical writing are exceedingly scarce and a book of this character should be a great aid to the technical student and the engineer in presenting articles on technical subjects in such a way as to make them acceptable and interesting, as well as instructive. Professor Earle's book is one that every engineer can study with profit.

As a usual thing an engineer does not relish the idea of haying to make reports or to write descriptions of works completed under his direction. As a result many engineers, young and old, have difficulty in getting their ideas on paper in a clear and concise manner, and those who try to find assistance on such matters have difficulty in finding just the kind of help they desire. The aim of this book is to give engineers such assistance as will enable them to present writings which possess the fundamental qualities of style, namely, accuracy, completeness, logical and economical presentation.

A feature of the book which cannot be too highly commended is the use of examples of good engineering writings in amplifying and elaborating the text.

The first part of the book consists of a study of the principles of logical structure. In the first chapter of this book the author very appropriately places great emphasis on the analysis of articles by means of synopsis; for a synopsis lays

bare and magnifies the logical structure as no other method can. The fundamental principles of technical writing are next given; these include the general principles of accuracy, completeness, logicalness and economy of presentation, and the principles of logical structure, order and division.

Descriptive and narrative exposition and directions are given next, followed by a treatment of these three rhetorical forms as combined in technical articles. A notable feature of each chapter is a summary of the principles special to each rhetorical form.

Part II treats of the practical application of the principles given in part I, for, as the author says, "the study of principles alone cannot be expected to give the engineer the ability to express his ideas in the most effective way." "In engineering reports, textbooks and magazine articles, we find crudeness in the structure of sentences and of paragraphs and ineffectiveness of general structure, such as we do not find in the writings of equally intelligent members of other professions. For this reason, and because exposition is more than any other form a matter of logical presentation, the engineer would profit by making himself familiar with fundamental principles."

In this part are given the essentials of logical structure and the principles to be observed and methods to be used in addressing general readers and specialists. The form of the final writing is treated in a very interesting manner, discussing the general plan to be adopted for a book, the division and arrangement of chapters and paragraphs, the sentence structure, punctuation, choice and order of words and other rhetorical principles which should be observed.

The methods of writing short reports, short treatises, longer treatises, and the methods followed by more experienced writers are given in the final chapter. An appendix of illustrative examples of technical writing, "not presented as models, but chosen to show that conclusions which may be reached from a theoretic study of exposition, are not mere theory, but are principles observed in actual writing."

No one will deny that the engineering profession in general does not enjoy a very high standard of ability in the field of technical writing, and such books as this one should be of great aid in raising that standard to a higher plane.

DATA FOR USE IN DESIGNING CULVERTS AND SHORT-SPAN BRIDGES. By Charles H. Moorefield. Bulletin No. 45, Office of Public Roads, U. S. Dept. of Agriculture, 39 pages, illustrated. Gratis.

This bulletin, as the name implies, is meant to supply suggestions and preliminary data for designing culverts and short-span bridges to engineers and experienced foremen. The bulletin discusses the area of waterway required, based on the well-known Talbot formula, and the merits of various materials for culverts. Specifications for reinforced concrete are given, including specifications for steel. The various types of culverts and bridges are next treated, beginning with a general statement of the assumptions as to stresses and loadings used in the designs. Plans and tables of quantities for various sizes of slab-top culverts, box culverts, T-beam bridges and incased I-beam superstructures and plain concrete arches are given. These should be of value to the engineer in checking various designs. Typical details of railings, end wing walls, plain and reinforced concrete, abutment walls, plain and reinforced, are given with tables of quatities. The "rules of thumb" given for the proportioning of end and wing walls are very clear in stating for what kind of soil the various formulæ should be used. For instance, for medium clay foundation the rule for base width of plain concrete wing wall is given as $0.4\ H + 21$ inches where H = height of wall above footing. It would seem that these formulæ should err on the side of safety, as evidently has been the desire. Complete specifications for reinforced concrete bridge construction are given. The pamphlet ends with a plea for æsthetic consideration in the design of bridges, and a few illustrations of attractive bridges are cited as examples. This little book contains much interesting and valuable information and every designing engineer should have a copy.

The Signal Department

RAILWAY SIGNAL ASSOCIATION.

The stated meeting of the Railway Signal Association was called to order by B. H. Mann, signal engineer of the Missouri Pacific Railway, at 9:30 a. m. on Monday, March 17, in the Florentine room of the Congress Hotel, Chicago. The attendance was very much better than that of a year ago.

COMMITTEE III—POWER INTERLOCKING.

Report of Sub-Committee "A."

A. B. duBray, Chairman.

Sub-committee "A" submitted the following for discussion:

Specifications for Annunciator Bells.

Specifications for Push Buttons for Bells, Train Drops, etc.

Specifications for Floor Pushes.

Specifications for Fuses.

Discussion.

The above specifications were passed with some changes and additions. During the discussion the principal objections advanced were: If the specifications for train drops, annunciator bells and push buttons passed as they stood, they would exclude apparatus which is now in general use in telephone practice, and commercial apparatus would be passed up for special apparatus which would in all probability cost more and be of increased size.

T. S. Stevens (A., T. & S. F.)—I do not think it is necessary to have annunciator coils in accordance with association specifications, as they were intended for use in larger instruments.

Chairman—We decided it was best to use four coils, so thought we might as well comply with the rest of the specifications. In "K" we need heavy binding posts, because we frequently have heavy wires on these posts.

T. S. Stevens (A., T. & S. F.)—At first these specifications will knock out all commercial types.

Chairman—We realized nothing on the market would pass these specifications.

A. G. Shaver (C., R. I. & P.)—I think we go too much into detail in specifying a nickle-plated gong and pressed steel cover. I think we should specify the energy a bell must work with, rather than give the amperes and resistances.

T. S. Stevens (A., T. & S. F.)—I doubt very much whether the material warrants these rigid specifications.

Chairman—We considered this subject carefully and thought best to submit an A1 specification. If anyone wants cheaper apparatus they can use it. However, if they want a first-class material, they could require R. S. A. specifications.

J. C. Mock (M. C.)—I suggest the committee be asked to draw a specification which will permit the use of high grade equipment now on the market for use in telephone installations.

A. H. Rudd (Penn.)—I think the heading of the specification should be made more specific. A ⅝ inch air gap is necessary in a bell circuit to protect against lightning. If the bell is not exposed to lightning a cheaper bell could be used.

A. G. Shaver (C., R. I. & P.)—I move the committee consider revisions to these specifications, in view of the discussion.

T. S. Stevens (A., T. & S. F.)—I second the motion. I know we will not use this apparatus, as it is probable the telephone companies have developed more compact and cheaper instruments which work satisfactorily.

L. S. Rose (C., C., C. & St. L.)—I think the committee is right in taking the maintenance into account. If we have a wound coil, we can repair a bell by putting in a new coil and save the rest of the bell. The rest of the material will not be special, as we will be using it in other apparatus, according to R. S. A. specifications.

J. Beaumont (C. G. W.) moved as an amendment to the original motion that the specifications be accepted by the association.

The president put the amendment to vote and it was lost. The original motion, that the committee consider the specifications with regard to revisions, was voted upon and carried.

The specifications for floor pushes was then taken up. Mr. Stevens moved that the specifications be accepted with the same consideration that applied to the specifications for annunciators. After some few minutes of discussion the motion was carried.

The next specification was that for fuses. After considerable discussion Mr. Stevens moved that the specifications be accepted, with the understanding that the committee would take into consideration the various suggestions which had been made during the discussion.

COMMITTEE III—POWER INTERLOCKING.

Report of Sub-Committee "C."

I. S. Raymer, Chairman.

This sub-committee was instructed to prepare plans for wire ducts, terminal boxes and manholes.

The report of sub-committee "C" was presented by I. S. Raymer. After considerable discussion the specifications were put to a vote and passed, with the consideration that the committee investigate all points brought out in the discussion.

Discussion.

A. G. Shaver (C., R. I. & P.)—Under "pipe coatings" are the threads galvanized or protected in any way? This is the weakest part of the conduit and should receive attention.

C. E. Denney (L. S. & M. S.)—I believe the inside coating should be hot galvanized. I would move this revision, in clause 4 eliminate "hot galvanized, electro galvanized or sherardized" and substitute "The interior of the pipe shall be enameled."

T. S. Stevens (A., T. & S. F.)—I think the most serviceable conduit on the market is either galvanized or sherardized first. Enameling alone will not protect against rust.

C. E. Denny (L. S. & M. S.)—I disagree, and think enameling would be a very effective outer coating, if it could be kept on while handling.

C. A. Christofferson (N. P.)—I suggest in (3) it be specified that all cutting and threading must be done before the conduit is galvanized or sherardized.

F. P. Patenall (B. & O.)—I think some tests should be made before we determine this question. It seems to me either sherardizing or enameling is sufficient, if properly done.

J. Beaumont (C. G. W.)—I move the adoption of these specifications.

Carried.

REPORT OF COMMITTEE V.

Manual Block.

Thos. S. Stevens, Chairman.

Sub-committee "B" of committee V, to whom was assigned the preparation of rules for the maintenance and operation of interlocking plants and block signals, submitted its report for discussion.

The standard rules of the American Railroad Association were accepted as a basis, but for economical reasons were not printed in the report, excepting only such rules as were recommended for revision, and such additional rules as were recommended for adoption. Of the present rules for signalmen, six were revised. The main changes being the elimination of the hand signaling for that of caution cards. For supervisors, signal foremen and maintainers the following number of rules for maintenance were given: 13 for supervisors, 11 for signal foremen and 50 for maintainers.

REPORT OF COMMITTEE ON STANDARD DESIGNS.

J. C. Mock, Chairman.

This committee submitted drawings for cast iron anchor posts for use in concrete foundations, drawing showing proper location of detector bars and clip bolts, drawing for stuffing box for 1-inch pipe, also stuffing box for wire line, and drawings showing the connections for double slip and movable point frog. Also drawings for lock rods, operating connections and insulations.

Discussion.

J. C. Mock (M. C.)—We recommend a change allowing a variation in the tang piece end of $^{15}/_{16}$ to $^{63}/_{64}$ inch, as the process of manufacture requires a little leeway.

This recommendation was adopted.

A recommendation for a reduction in required tensile strength for wrought iron pipe was also adopted.

Mr. Mock stated that the reason for this was that it was impossible to get as high a tensile strength as in steel, which is more homogeneous. He also asked for an expression of opinion with regard to arm spacing.

C. E. Denny (L. S. & M. S.)—I move that it is the sense of this meeting that the standards should be completed on a 7 foot and 8 foot basis.

The motion carried.

C. J. Kelloway (A. C. L.)—I move drawing 1225 be adopted for presentation at the convention.

Carried.

J. C. Mock (M. C.)—I move the adoption of the stuffing box for wire. It is similar to that submitted last year, but we have eliminated one wire from the pipe.

The motion carried.

W. H. Elliott (N. Y. C. & H. R.)—It appears to me that the switch lock and front rods on the double slip are similar to the Pennsylvania standards, and think they are all right. I would suggest, however, that the throw of switch points be made 5 inches, throw of frogs 4 inches, and that tie plates be shown on all ties.

A. H. Rudd (Penn.)—We used to have 3½ inches on frogs and 4½ to 5 inches on switches. We now use 4 inches on everything. Four inches is plenty. There is no need of 5 inches.

J. A. Peabody (C. & N. W.)—I believe from both a trackman's and signalman's standpoint the longer the throw, the better. The shorter the throw, the shorter the distance at the heel, and the more shock when each wheel passes the switch.

M. Waldron (I. R. T.)—The committee's suggested standard can be used with either a 4 or 5 inch throw; it would satisfy all of us. We put the curved switch point a foot or 1½ feet ahead of the straight one, and find it prolongs the life of the switch point and stock rail. Would the committee like to consider that detail?

A. H. Rudd (Penn.)—We waited several years for the R. S. A. to adopt a standard slip switch, before we designed this one. It has been entirely satisfactory. Some railways won't allow staggered points on main line, and I think we should go slow on that question.

C. E. Denny (L. S. & M. S.)—I move that it be the sense of this meeting that each pair of double slip points be connected by a non-adjustable rod.

Motion lost.

REPORT OF COMMITTEE VIII.

Electric Railways and A. C. Signaling.

H. S. Balliet, Chairman.

This report covered specifications and requisites of apparatus and material for alternating current automatic block signaling

on all railways, except those using direct or alternating current for propulsion. After a short discussion, the motion made by Mr. Balliet, that the specifications beginning with page 29 be accepted as printed, was carried.

METHOD OF RECORDING SIGNAL PERFORMANCE.
Mr. W. N. Manual, Chairman.

This committee was instructed for 1913 as follows:

"Investigate and report on the basis now used on various railways in recording interruptions to traffic by signals, and in computing efficiency of signal performance."

Letters were addressed to fifty railways, reported by the Interstate Commerce Commission as having in service automatic block signals, and the following information requested:

"1. Copies of forms now being used, together with instructions issued as to the proper method of filling them out.

2. Formula used in computing signal performance.

3. Suggestions as to desirable alterations in or additions to the method used.

4. Should comparative cost per mile or signal blade enter into the computations of comparative efficiency as between divisions, systems or railways?

5. Any general comments on methods now used, forms that have been presented to the association, or information that may guide the committee in best serving the association and the railways.

The committee will appreciate any information you can consistently furnish and would like to have eight (8) copies so that each member may give your reply individual consideration."

From the number of replies and signal report forms received the following typical signal report forms were prepared:

Signal Report—Form A is a blank in postcard form, addressed to the supervisor of signals on reverse side, to be filled out by the conductor or engineman, and given to the operator or signalman at the first open telegraph office, for telegraphic transmission to the dispatcher and subsequent mailing to the supervisor of signals, or to be telephoned direct to dispatcher by using a portable telephone. The form contains the information shown on all other forms except the following:

1.—Indicators.
2.—Track being repaired.
3.—Hand car in block.
4. Line wires down.
5. Lightning storm.
6.—Signal was clear and failed to go to stop position.

Signal Report—Form B is a form used by dispatchers in recording information transmitted from forms numbers A and C and by operators or signalmen in receiving and transmitting similar information to the maintainer. The dispatcher, after receiving the maintainer's report, sends copies to the superintendent and the supervisor of signals.

Signal Report—Form C. A copy of this form is filled out and given to operator or signalman for transmission to the dispatcher, copies are mailed to the supervisor of signals, and on some railways, to the signal engineer. The maintainer may keep a copy for his record.

Additional information contained in other forms used by maintainers for daily, weekly or monthly report:

1.—Number of trains stopped—Passenger, freight.
2.—Date of last inspection and condition of function at that time.
3.—Trains that disregard stop signals.
4.—Indicators—tower, switch.
5.—Report of counter readings.

Computing Efficiency of Signal Performance.

Forms for signal engineers and supervisors of signals, showing classification of failures and methods of computing efficiency of signal performance, will be presented at the June meeting. Forms received involve a number of methods, and the classification includes considerable detail with no semblance of uniformity. More time for their consideration is necessary than can be spared at this meeting; consequently the committee concluded to report briefly upon the various factors involved. The figures shown are to represent conditions on a railway and are used to illustrate the computations. Let:

F=failures: 10.
S=total number of signals: 100.
T=trains stopped: 50.
O=total number of trains operated: 1,500.
P=total number of signal operations: 150,000.

Formulae.

Signal operations=OS=150,000.

Trains stopped per failure $\frac{T}{F}$=150.

Signals per failure $\frac{S}{F}$=10.

Trains operated per faiure $\frac{O}{F}$=150.

Signal operations per failure $\frac{P}{F}$=15,000.

Trains operated per train stop $\frac{O}{T}$=30.

Signal operations per train stop $\frac{P}{T}$=3,000.

Maintenance efficiency $\frac{E-F}{S}$=90%.

Operating efficiency $\frac{O-T}{O}$=96.6%.

One road arbitrarily assumes five train stops per failure. In the event of a power failure, or the transmission of power, one road counts only one signal failure, irrespective of the number of signals affected.

Signal Movement Defined.

1. A signal movement is counted for every movement of the blade from stop to caution, caution to clear, and if there is no intermediate stop position, a movement is counted from stop to clear. This necessitates the use of signal counters and a monthly reading of them.

2. One movement per signal is counted for each train movement. This information is taken from the dispatcher's sheets.

Personals

Operating.

W. J. Stoneburner has been appointed general superintendent of the Alabama, Tennessee & Northern R. R. at York, Ala. He first entered railway work with the Rome, Watertown &

W. J. STONEBURNER, General Superintendent Alabama, Tennessee & Northern Ry.

Ogdensburg R. R., holding successfully positions of laborer, operator and agent. He was later appointed train dispatcher on the Wisconsin R. R., and chief dispatcher on the Duluth & Iron Range Ry. He served as superintendent of telegraph and chief dispatcher on the Chicago & Eastern Illinois R. R., and as trainmaster and chief dispatcher on the Buffalo, Rochester & Pittsburgh R. R. He was appointed superintendent of the Quincy, Omaha & Kansas City R. R., and held a similar position on the Missouri, Kansas & Texas Railway of Texas, where he was in charge of maintenance of way and transportation. He was for a time vice-president and general manager of the Texas City Terminal & Transportation Company, in charge of operation and construction. He was connected with the industrial department of the Missouri, Oklahoma & Gulf Railroad, on statistical work. On February 26, 1913, he was appointed general superintendent, as noted above, in charge of the transportation, mechanical and maintenance of way departments.

E. W. Morrison, formerly assistant superintendent, has been appointed superintendent of the Chicago, Milwaukee & St. Paul Railway, at Chicago, Ill. F. E. Willard, formerly trainmaster, has been appointed superintendent at Missoula, Mont.

A. E. Wallace, superintendent of the Chicago, Rock Island & Pacific Railway, has been transferred from Cedar Rapids to Manly, Ia.

J. F. Hickey, superintendent of the Missouri, Kansas & Texas Railway at McAlester, Okla., has been transferred to Smithville, Tex., as superintendent of the Missouri, Kansas & Texas Railway of Texas, effective March 10. A. F. Kinger, formerly engineer maintenance of way of the Missouri, Kansas & Texas Railway of Texas, has been appointed superintendent of the Missouri, Kansas & Texas Railway at McAlester, Okla., succeeding J. F. Hickey.

W. Coughlin has been appointed general superintendent of the Missouri, Oklahoma & Gulf Railway, office at Muskogee, Okla.

J. D. Melville, superintendent of the National Railways of Mexico, has been transferred from Cardenas, S. L. P., to Chihuahua, Chih. F. R. Westrup, superintendent, has been transferred from Chihuahua, Chih., to Cardenas, S. L. P., succeeding Mr. Melville.

C. F. Smith, formerly assistant superintendent, has been appointed superintendent of the Oregon Short Line R. R. at Pocatello, Ida., succeeding W. R. Armstrong.

F. J. Hawn has been appointed superintendent of the St. Louis Southwestern Railway of Texas at Mt. Pleasant, Tex., effective March 27. Wm. Mosby has been appointed superintendent of transportation at Tyler, Tex. E. Richards has been appointed superintendent at Pine Bluff, Ark.

L. C. Maxwell, Engineer Maintenance of Way Algoma Central & Hudson Bay Ry.

James MacMartin, Assistant Chief Engineer Delaware & Hudson Co.

J. C. Muir has been appointed general superintendent of the Chicago, Terre Haute & Southeastern Railway, office at Chicago, Ill.

W. E. Morse has been appointed general manager for the receivers of the Denver Northwestern & Pacific Railway, office at Denver, Col., effective April 1.

J. Caldwell, formerly superintendent of terminals, has been appointed superintendent of the Grand Trunk Railway at Detroit, Mich. J. Ehrke, formerly superintendent of terminals, has been appointed superintendent at Battle Creek, Mich.

Lewis W. Baldwin, formerly engineer maintenance of way, has been appointed superintendent of the Kentucky division of the Illinois Central Railroad at Louisville, Ky., succeeding A. H. Egan, who has been promoted to general superintendent at Memphis, Tenn. George W. Berry has been appointed terminal superintendent at Chicago, succeeding J. H. Brinkerhoff, resigned to accept service with another company. The above appointments were effective April 1.

J. P. Burrus, superintendent of the International & Great Northern Railroad, has been transferred from Mart to Palestine, Tex., succeeding T. C. Radney. W. D. Jenkins has been appointed inspector of transportation at New Orleans, La.

H. W. Purvis, superintendent of the Seaboard Air Line Railroad, has been transferred from Americus, Ga., to Jacksonville, Florida.

A. W. Montague, terminal superintendent of the Texas & Pacific Railroad, has been transferred from Dallas to Ft. Worth, Tex. W. J. Jenkins has been appointed inspector of transportation at New Orleans, La.

Alfred H. Egan has been appointed general superintendent of the Yazoo & Mississippi Valley Railroad at Memphis, Tenn., succeeding George W. Berry, appointed superintendent of terminals at Chicago, effective April 1.

Engineering.

C. F. W. Felt, formerly chief engineer, has been appointed chief engineer Santa Fe system of the Atchison, Topeka & Santa Fe Railway, succeeding C. A. Morse, appointed chief engineer of the Chicago, Rock Island & Pacific Railway.

L. C. Maxwell, who has been appointed engineer maintenance of way of the Algoma Central & Hudson Bay Railway, was born at Detroit, Mich., and began railway work in 1889 as rodman on the Detroit, Bay City & Alpena Railroad. He held successively the positions of levelman and transitman on loca-

tion. In 1889 he was appointed terminal engineer on the Fort St. Union Depot, Detroit, and went with the Chicago & West Michigan Railway as draftsman on resurvey work in 1892, later being appointed assistant engineer on maintenance. He went with the Cincinnati, Hamilton & Dayton Railway in 1900 as engineer in charge of property and on general maintenance work. In 1911 he was appointed engineer maintenance of way of the completed portion of the Algoma Central & Hudson Bay Railway, and division engineer of the portion under construction. His recent appointment was engineer maintenance of way of the whole line, including the newly completed portion.

W. S. Basinger has been appointed division engineer of the Southern Kansas division of the Atchison, Topeka & Santa Fe Railway at Chanute, Kan., effective February 24. He graduated from Purdue University and entered the service of the Santa Fe in 1907, and has held successively the positions of rodman, masonry inspector, transitman and assistant engineer.

Geo. L. Huckins has been appointed division engineer of construction of the Boston & Maine Railroad at Boston, Mass. C. J. Griffin has been appointed division engineer of construction at Greenfield, Mass.

W. F. Steffens, formerly engineer of structures on the Boston & Albany Railroad, has been appointed assistant chief engineer,

F. L. Thompson, Engineer of Construction Illinois Central R. R.

Chesapeake & Ohio Railway, office at Richmond, Va., effective April 1.

J. B. Berry, formerly chief engineer, has been appointed assistant to president of the Chicago, Rock Island & Pacific Railway, office at Chicago. C. A. Morse, formerly chief engineer of the Atchison, Topeka & Santa Fe Railway, has been appointed chief engineer of the Chicago, Rock Island & Pacific Railway, office at Chicago, effective April 1.

R. P. Rockefeller, formerly assistant engineer, has been ap- Railway at Dalhart, Tex.; he has been with the Rock Island Lines for 10 years, the last seven as assistant engineer. A. C. Shields has been appointed division engineer at Little Rock, Ark., succeeding E. Nugent.

James MacMartin, formerly construction engineer, has been appointed assistant chief engineer of the Delaware & Hudson Company, office at Albany, N. Y. F. D. Anthony has been appointed construction engineer at Albany, N. Y., succeeding Mr. Martin.

James Boyd has been appointed assistant engineer of the Grand Trunk Railway at Hamilton, Ont. H. A. Palmer has been appointed assistant engineer at Toronto, Ont. L. I. Stone has been appointed assistant engineer at London, Ont.

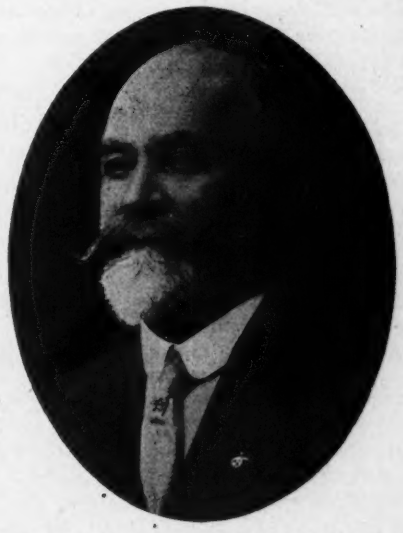
Daniel J. Brumley, formerly engineer of construction, has been appointed engineer maintenance of way of the Illinois Central Railroad and the Yazoo & Mississippi Valley Railroad, office at Chicago, succeeding L. W. Baldwin, appointed superintendent. F. L. Thompson, formerly engineer of bridges and buildings, has been appointed engineer of construction, succeeding Mr. Brumley, office at Chicago. Maro Johnson, formerly assistant engineer of bridges and buildings, has been appointed engineer of bridges and buildings, office at Chicago. The above appointments were effective April 1.

C. W. Archibald has been appointed resident engineer of the Intercolonial Railway of Canada, at New Glasgow, N. S.

Effective March 17, J. H. Roach has been appointed assistant engineer of construction of the Lake Shore & Michigan Southern Railway, office at Cleveland, O., succeeding J. W. Crissey, deceased.

F. C. Flynt has been appointed assistant engineer of the Louisville & Nashville Railroad at Nashville, Tenn., succeeding Owen Crawford, appointed roadmaster.

Arthur Stillman Tuttle, recently appointed division engineer of construction of the New York, New Haven & Hartford Rail-



Hans Helland, Engineer of Construction San Antonio & Aransas Pass Ry.

road, was born in Dorchester, Mass., in 1865. He graduated from the Dorchester high school in 1882, and entered railway service the same year with the Boston & Providence Railroad, holding successively the positions of rodman, transitman and assistant engineer. In 1887 he was put in charge of field work, double tracking, reconstruction and location, on the B. & O. Railroad and the Old Colony Railroad. In 1890 he was assistant engineer and later chief engineer on the construction of the Plymouth & Middleboro Railroad. He was later appointed principal assistant engineer of the Central Railroad of New Jersey and the New York, New Haven & Hartford Railroad, on grade crossing elimination on the Providence division. From 1899 to 1912 he was assistant engineer on grade separation and on the construction of two large draw bridges, and also in charge of getting out plans for grade elimination on the New York, New Haven & Hartford Railroad. He held the position of assistant engineer until his appointment as division engineer of construction at Boston.

W. J. Backes has been appointed engineer maintenance of way of the New York, New Haven & Hartford Railroad at New Haven, Conn., succeeding L. J. Carmalt. E. L. Taylor has

been appointed assistant engineer maintenance of way at New Haven. R. B. Spencer has been appointed division engineer at New Haven, Conn. R. C. Huntington has been appointed assistant engineer of bridges and buildings at New Haven.

F. Daam has been appointed division engineer of the Pennsylvania Railroad at Baltimore, Md.

E. G. Johnson, division engineer of the Pennsylvania Lines West, has been transferred from Allegheny to Pittsburgh, Pa.

Hans Helland, formerly engineer maintenance of way, has been appointed construction engineer of the San Antonio & Aransas Pass Railway at San Antonio, Tex.

Maintenance of Way.

J. Fink has been appointed roadmaster of the Ann Arbor Railroad, at Ann Arbor, Mich. C. Lindsay, roadmaster has been transferred from Alma to Cadillac, Mich.

D. R. Davidson has been appointed roadmaster of the Canadian Northern Railway at Portage La Prairie, Man. G. Eyford, roadmaster, has been transferred from Saskatoon to Prince Albert, Sask. C. Peterson has been appointed roadmaster at Portage La Prairie, Man. J. Neilson, roadmaster, has been transferred to Stettler, Alb.

C. F. Hayes has been appointed roadmaster of the Central of Georgia Railway at Cuthbert, Ga., succeeding J. P. Mills.

J. H. McKittrick, roadmaster, Chicago & Northwestern Railway, has been transferred from Ishpeming to Escanaba, Mich. Thos. Wood has been appointed acting roadmaster at Mason City, Ia., succeeding C. F. Tabbert.

W. G. Dungan, roadmaster of the Chicago, Burlington & Quincy Railroad, has been transferred from Orleans to McCook, Neb.

E. W. Budd has been appointed roadmaster of the Chicago, Indianapolis & Louisville Railway, at Bedford, Ind., in charge of territory from Harrodsburg to Louisville, the Indiana Stone road and the French Lick branch.

Thomas McGee, roadmaster of the Chicago, Milwaukee & St. Paul Railway, has been transferred from Jackson, Minn., to Madison, S. D. J. V. Robinson has been transferred from Minneapolis to Fairbault, Minn. J. H. Tayek, recently appointed acting roadmaster at Mason City, Ia., has been permanently appointed roadmaster of the eastern part of the Iowa and Dakota division, at North McGregor, Ia., succeeding J. J. Burke, resigned, effective March 27.

P. Freeman has been appointed roadmaster of the Galveston, Harrisburg & San Antonio Railway, at Del Rio, Tex.

F. J. Heinen has been appointed roadmaster of the Great Northern Railway at Superior, Wis. J. J. Hess has been appointed roadmaster, also at Superior, Wis. E. H. Brock has been appointed assistant roadmaster at Great Falls, Mont. E. C. Carter has been appointed assistant roadmaster at Everett, Wash. T. R. Conners, assistant roadmaster, has been transferred from Butte to Great Falls, Mont. J. F. Fredrickson has been appointed assistant roadmaster at Moorhead, Minn. John Hamilton has been appointed assistant roadmaster at Havre, Mont. S. O. Luno has been appointed assistant roadmaster at Grand Forks, N. D. T. McIntyre has been appointed assistant roadmaster at Burlington, Wash. Charles Tedholm has been appointed assistant roadmaster at Judith Gap, Mont. W. R. Whitby, assistant roadmaster, has been transferred from Grand Forks, N. D., to Moorhead, Minn.

Owen Crawford, formerly assistant engineer, has been appointed roadmaster of the Louisville & Nashville Railroad, at Bay St. Louis, Miss., succeeding W. G. Brown.

L. C. Levee has been appointed roadmaster of the Clarendon, Brinkley and Helena branches of the Missouri Pacific Railway at Helena, Ark., effective March 10, succeeding J. D. York. E. B. Zappe has been appointed roadmaster at McGehee, Ark., succeeding S. C. Ramsey.

J. C. Hill has been appointed roadmaster of Morgan's Louisiana & Texas Railroad at Morgan City, La.

W. C. Cole, roadmaster of the Pere Marquette Railroad, has been transferred from Edmore to Saginaw, Mich. S. S. Smith has been appointed roadmaster at Edmore, Mich., succeeding W. C. Cole.

L. R. Wilson has been appointed supervisor of the Philadelphia & Reading Railway at Reading, Pa.

O. M. Barlow has been appointed roadmaster of the Southern Pacific Company, at S. Vallejo, Cal., succeeding B. Roland, transferred. H. L. Lyon has been appointed roadmaster at McMinnville, Ore., vice H. M. Tolston. B. Rolston, roadmaster, has been transferred from S. Vallejo, to Tracy, Cal. J. Shea has been appointed roadmaster at Imperial Junction, Cal., vice E. L. Casey.

W. M. Weiland has been appointed roadmaster of the White River & Southwestern Railway (a Missouri Pacific line) at Batesville, Ark., effective March 1, succeeding R. Cantrell.

N. C. Peterson has been appointed roadmaster of the Union Pacific Railroad at Green River, Wyo. A. V. Sanders has been appointed roadmaster at Onaga, Kan.

Bridges and Buildings.

C. Carver has been appointed bridge and building master of the Canadian Northern Railway, at Portage La Prairie, Man.

R. Burke has been appointed assistant inspector of bridges and buildings of the Chicago, Indianapolis & Louisville Railway, office at La Fayette, Ind.

J. W. Lemon has been appointed master carpenter of the Great Northern Railway at Minot, N. D., effective March 5, succeeding W. A. Batchellor.

G. A. Rodman has been appointed inspector of bridges and buildings of the New York, New Haven & Hartford Railroad, at New Haven, Conn.

Signalling.

J. E. Saunders has been appointed office engineer in the signal department of the Delaware, Lackawanna & Western Railroad, office at Hoboken, N. J.

A. H. Schott has been promoted from assistant signal supervisor to supervisor of signals of the Michigan Central Railroad, at Detroit, Mich., in charge of work on the Bay City and Toledo division, Cairo and Saginaw branches, and the Detroit Terminal Railroad. N. E. Morrell succeeds Mr. Schott as assistant signal supervisor at Detroit, Mich. The above appointments were effective March 1.

R. E. Taylor has been appointed assistant signal engineer of the New York, New Haven & Hartford Railroad, at New Haven, Conn.

W. J. Eck, formerly electrical engineer, has been appointed electrical and signal engineer of the Southern Railway, office at Washington, D. C.

The Mill Valley & Mount Tamalpais Scenic, the corporation now owning the railway to the summit of Mount Tamalpais, in California, and the Mount Tamalpais & Muir Woods, recently organized, have joined in an application to the California railway commission for permission to sell the property of the old to the new company. The new company is incorporated with a capital stock of $500,000, and by the terms of the sale that has been arranged by the two companies, the stockholders in the old company will get $300,000 of this stock for their holdings. Several improvements to the road are in contemplation.

The Northern California R. R. Navigation Co. has been incorporated to build a railway from Eureka up the Klamath river to Fort Jones, Cal.

The North State is said to have been chartered in North Carolina to build a line from Bunn to Raleigh, with power to extend beyond the latter plant if desired.

The Oregon Short Line is said to be planning to begin work this spring on the extension of its Twin Falls branch from Rogerson to Wells, Nev., where a connection would be made with the Southern Pacific.

The Pennsylvania has acquired control of the Cornwall & Lebanon, a 22-mile line running from Lebanon to Conewaga.

The Union Pacific, it is said, is considering the construction of the Kearney & Black Hills branch from Stapleton to connect with the main line west of North Platte, Neb.

The Maintenance of Way Department

Washouts

ONE OF the chief causes of trouble in maintaining track is water. It gets into the sub-grade, in small quantities, and softens the track foundation. It causes embankments to shrink and wash away and ditches to fill up. Water is back of all the trouble which is experienced with heaving track in the winter.

When water falls in larger, or unusual quantities, a great deal more is asked of the foreman than just maintenance. Prevention of damage by floods, as far as possible, is only obtained by the utmost vigilance and continual inspection of the foreman. Knowledge of precautionary measures which will prevent or diminish the effect of high water is of exceedingly great value to all trackmen.

Furthermore, where it is impossible to save the track by any means, methods for quickly repairing washouts, or for quickly getting track into operating condition, are of great value, especially when viewed from the standpoint of the traffic and operating departments of a heavy traffic railway.

For the reasons stated above we would like to obtain the benefit of the experiences of a large number of trackmen for publication in this department. Your methods and experience, while they may appear commonplace enough in your own estimation, may be a revelation to others. It is not intended that the article should cover all of the points mentioned below, or be confined to them. The widest latitude is encouraged.

The following outline should, however, suggest something as the basis for an article.

What has been your experience with:

System of inspection to discover evidences of weakness or danger.

Indications which warn of impending high water.

Preliminary precautions taken in places liable to wash out—such as ditching, etc.

Combination of conditions which caused very high water in a particular locality.

Efforts made to hold submerged track in place.

Methods used for quickly getting track into service after water has subsided.

Special methods used to get across or around bridges, where approach is washed away.

Photographs, or rough pencil sketches, should be submitted by all means, if possible, to improve the article. Pencil sketches will be redrawn by our artist to present a neat appearance.

All articles on the above subject accepted for publication will be paid for at an increased page rate.

Address all contributions to Editor, Railway Engineering, 431 South Dearborn street, Chicago.

Method of Obtaining, Caring For and Retaining Track Laborers.

K. L. Van Auken.

IT IS THE opinion of a majority of railway men who have to do with both construction and maintenance, that the present methods of obtaining and retaining laborers are in most cases wrong in principle, or inadequate. If the labor problem is satisfactorily met, the problem of the section foreman is also solved, for the solution would imply intelligent, steady laborers.

A system which would tend to give satisfaction, would have as features:

(1) A company labor bureau.
(2) Company boarding camp or commissary.
(3) Graded rates of pay for section laborers.
(4) Provisions for educating employes if they so desire.
(5) Promotion (always) according to ability and results accomplished.
(6) Combination of maintenance and construction organization.

On first sight it appears that this is asking a good deal of the railways, but we believe by this means permanent labor can be obtained; the laborer will probably devote his entire life to the company, and is entitled to the maximum amount of advantages.

No one will deny that conditions are so bad that further retrogression must be arrested, and to do this, it is also conceded, will require radical means and methods.

There would probably be no labor shortage if the laborers in this country were employed on the work for which they are best fitted, and each did a fair day's work. All of those who have handled gangs of different nationalities realize that there is frequently one kind of work to which a certain nationality is best adapted, and many other kinds of work to which that nationality is ill adapted.

Even in men of the same nationality there is a great difference as to their adaptability to different kinds of work, and the way to get the proper men for each class of railway work is to have a labor bureau whose business it is to keep in close touch with conditions in the field and the labor market. A commercial labor agency will send out a sewer digger on a track gang, in preference to a good track man, if the former will pay a larger fee. A labor agency will send out undersized men, weak men physically, mentally and morally, if they will pay the fee.

All this could be changed, and only will be changed, by expert hiring of men by a company labor bureau, and this department should be put in charge of an expert track man who has wide knowledge gained from experience and observation, and who, also, will keep in the closest possible touch with the requirements and developments on his own and other railways from day to day. The company labor bureau, if efficient, could eliminate the interpreter, and that vitally necessary; could eliminate extortion from laborers, and could eliminate many other abuses. All of this would revert to the company's gain in increased efficiency.

Is there not a great inconsistency in hiring expert foremen, and then allowing any derelict to hire the men for these expert foremen to handle? The matter of first importance in producing any excellent fabric is the procuring of good raw material—that which will best serve the purpose. At present we do not hire our laborers that way.

A boarding camp or commissary is almost necessary if foreigners are to obtain anything like value for their money. The concessions made by railway companies of cars, bunks, etc., to their laborers (ostensibly) are really being made to the parasites who live off the laborer. Many nationalities, naturally

economical to excess, become still more so when their purchases of supplies carry a heavy duty to some go-between, either the interpreter or the labor agent who reserves the commissary privilege.

The furnishing of good board would involve little, if any, increase in cost to the railway company. Practically every gang of foreigners has its cook or cooks, who are enrolled and paid as laborers but never leave the camp. Two cooks to thirty or forty men are not uncommon.

The benefit to the white laborers, the hobos, would be very great if the company furnished good board and bunks. The hobo, even if improperly fed, can accomplish much work with the minimum of supervision on account of his track knowledge, intelligence and skill. His efficiency would undoubtedly increase if he was treated in accordance with humanitarian principles.

A man is entitled to increased pay with increased efficiency, but under present conditions the green track laborer generally receives as much as a laborer who has been in track work for years. In fact, an extra gang laborer usually receives more than a section laborer, although the former may have never worked on a railway before. Under these conditions there is no incentive for a man to increase his ability and efficiency. It is not surprising that poor results are being obtained.

We contend that track laborers' wages should be increased in proportion to increased efficiency, or in proportion to age of service; or, better yet, in proportion to both increasing efficiency and length of service. This would produce an incentive for the laborer to attain greater efficiency—such an incentive is not provided under present conditions, and is needed. This system would do away with the need for special apprentices. The highest paid man or men would be the next eligible for promotion.

The unskilled man working under the graded system of wages, would receive a wage commensurate with his usefulness, and the experienced man would also get wages commensurate with his usefulness. A powerful incentive would thus be introduced for holding the laborer who, through years of work, has attained a higher wage, and whose rights would be lost as soon as he quit; for on starting in again he would be paid only the lowest scale of wages.

The laborers who are most useful are those of ambition, those who have a desire to increase their own value to the company, and thus merit increased wages. Such men should be given every opportunity to better themselves and to fit themselves for higher positions. For this reason, some means should be provided for furnishing education in railway work, as desired, by the ordinary laborer and the section foreman. This would form still another bond between the man and the railway, and would result in greater efficiency, and more legible and exact reports.

Having established a good graded rate of pay, no deviation should be made from the principles. The rates should be so adjusted that the most efficient man, or men, would receive a specified wage, after having been in the service a certain period. More than ordinary efficiency should result in wages increasing faster than the average. In addition, all promotions from laborer to foreman, and above that, should be made absolutely, from the men in the highest paid class, and from these according to comparative ability. A deviation from this rule would soon spoil the effect of the system. Fair treatment must be insisted upon in any organization if high efficiency is attained.

It is very bad policy to hold a man on one job because he is efficient and very useful to his superior, when a higher and better job is given to another of less or doubtful ability. Such a policy is sure to become apparent and result in loss of efficiency and loyalty.

The final consideration is a "combination of maintenance and construction forces." Such a combination exists on some roads, but on many these organizations are entirely separate and distinct. The combination produces, first, harmony instead of rivalry between these forces. It also provides a way of obtaining steady foremen from maintenance work for extra gangs —men who can be relied upon—and gives the man who has charge of construction very valuable experience; he obtains a much broader knowledge in a few months of extra gang work than in years of ordinary maintenance work. It qualifies him, if promoted, to take efficient charge of both construction and maintenance. If an outsider is appointed foreman of an extra gang, which usually pays higher wages, an injustice is done the railway and the permanent employe, who is certainly entitled to all such rewards.

The investing of power of promotion entirely in any one man, will result in some abuses, unless the foreman is of the right sort. The only feasible way, however, to preserve discipline in a gang of men, is to make the foreman practically supreme. The minute a superior breaks in on the personal relations, especially if he reverses the foreman's orders frequently, he weakens the foreman's control over his men. The solution is to have good honest foremen. A great deal can be accomplished by the attitude of superior officers. A policy of fair dealing on their part will produce a similar spirit in the whole department.

A system as outlined above would, we believe, result in building up a strong organization in time—and in a comparatively short time. Abuses might arise, but few are likely if the policy is carried out fairly and confidently. It is, of course, impossible to find any system in which there will not be a few persons who will take advantage of any liberties accorded them. It is also realized that no simple system can be evolved which will cover entirely all conditions, and certain changes, additions, or subtractions, might be necessary in many cases.

RAILWAY LABOR CONDITIONS.

L. Brumaghim, Supervisor of Track.

At the present time there is room for improvement in Railway labor conditions in a great many different ways. Notwithstanding the fact that improvements are being made continually there is always room for more. One department of the railroads is coming into the limelight and is taking its share of attention of late; viz., the maintenance of way department. What is the reason for this? The answer is no doubt known to all. This department is the one which feels the existing labor conditions the most.

On account of the scarcity of labor for track work, the the ability of the supervisors and section foremen are put to severe test to secure enough men to fill out the various gangs. These conditions are due largely to the amount of state road and other public work going on at this time, which work pays a higher wage than the railway work. By impressing upon the

foremen that he should explain to the men in a sensible manner, that although they are not getting as much pay as could be had in other lines of work, the railroads will furnish them steady work and that they will have work when the other jobs are closed down on account of weather conditions or for other causes, I am endeavoring at least to hold the men I have and to secure as many more as possible.

We try to get section laborers locally to as great an extent as possible. If we are unable to do so and are obliged to depend upon foreign labor, we try to get the ones with families to locate at a particular point permanently. We sometimes house as many of our foreign laborers as we can accomodate in tool houses, or set off an old box car, which we allow them to occupy without rent. This is quite an inducement to foreign laborers as they would have to pay rent otherwise.

For extra gangs it is sometimes necessary to get the men through labor agents, and when men are secured in this way, the agent in the majority of cases endeavors to board the men that he furnishes; but this should be avoided as far as possible, as there is nearly always trouble, the men claiming that they are charged more for their supplies than they could be bought for elsewhere. When these conditions exist among the men, the foreman is not able to get the same results as when the men are satisfied, and I do not recommend the securing of men through labor agents and would do so only as a last resort.

The greatest labor producers outside of wages are efficient foremen. I have made a close observation of the different foremen and find that a first-class foreman is very seldom short of help, providing there are any men to be had, especially if the foreman is known. All laborers prefer to work for a foreman who thoroughly understands his work, for he knows that such a foreman will take interest in the work, make it easier for the men, and accomplish a great deal more work than the poor foreman.

To attain the highest efficiency in track forces, it will be necessary to educate the most efficient men, those with broader views, who will realize that the track work of the future will have to be done mostly by foreign labor, and who will devote a great deal of attention to the education of these foreign laborors in order to make them up-to-date trackmen. I have personally handled foreign laborers in gangs of from six to a hundred men, and can truthfully say that the results obtained were just as satisfactory as those obtained by American laborers, by my making an especial effort to teach them to do their work advantageously, by impressing upon them the fact that the more efficient they become, the more demand there will be for them and the more chances for promotion. I am pleased to say that a great many of these foreigners are now first-class track foremen.

An efficient track foreman is a man who thoroughly understands the rules and standards of the railroad for which he is working; one with ability to handle his work in a way which will insure the best results for the company with the least labor on the part of the men; one who will endeavor to awaken in his gang a spirit of co-operation to obtain such results, the same as if all had an individual financial interest in the railroad. The foreman who will earnestly endeavor to follow this policy of handling men will get good results out of practically any class of labor.

Labor, no doubt, is as good today as it ever was, but there must be different supervision. The old-time foremen, who made the most "noise" has no business on the present day railroads. It takes ability now to get the results that were obtained partly by main strength and "hot air" in the past. I recommended to all railroads that the future foreman receive a special training in the handling of men and the details of this line of work to increase the efficiency of track forces.

MACHINING TIES.

Editor *Railway Engineering:*

We think a machine for adzing and boring ties, both treated and untreated, into which spikes are to be driven, has some merit. This opinion is based on observation of results obtained on other railways. We are now installing one such machine as an experiment.

It is our plan to bore ties for present standard track only and not for that laid with the numerous smaller rails.

(Signed) J. R. W. Davis, Engineer Maintenance of Way,
Great Northern.

Editor *Railway Engineering:*

Our practice in adzing and boring ties is as follows: Bored ties are used only under our standard method of construction, with one size of rail (100-lb.), which requires ties to be bored for screw spikes in advance of being treated; this we find very effective and desirable. We do not use square spikes in connection with treated ties.

Where ties are not to be treated, adzing and boring, in my judgment, would prove a decided disadvantage, owing to the variable dimensions of rails used, and we find very little, if any, difficulty in direct spiking of untreated ties.

(Signed) Edward Gagel, Chief Engineer,
New York, New Haven & Hartford.

Editor *Railway Engineering:*

Where ties are to be treated, I am of the opinion that the boring of them for spikes and the adzing of them for tie plates before treatment would effect great economy in the preservation of timber and the laying of the track.

Ties for treatment are assembled in large quantities at the treating plant before treatment. The cost of adzing and boring these ties at the plant as they are transferred to the treating cylinders would be very small. The advantages would be the saving of destruction to the fibre of the timber, the better penetration of the oil, where creosote is used, in the portion of the tie in which it is most needed, the greater holding power of the spikes and the marked economy in cost of track laying. Such a practice would, of course, necessitate the boring of ties to suit different sections of rail, but this would mean only a little greater attention to detail in the distribution, which could be readily effected.

Where ties are not to be treated, they are not assembled in yards as a rule and, as a consequence, the assembling of them simply for boring and adzing, or the transferring from point to point of a boring and adzing machine would, in my judgment, cost so much as to overcome the benefits to be gained.

(Signed) A. S. Baldwin, Chief Engineer,
Illinois Central.

SUBSTITUTION OF PIECE WORK FOR DAY LABOR—NO. 2.

W. K. Walker, Division Engineer.

The substitution of piece work for day labor in some of the departments of railway work has resulted in considerable saving.

The question comes now: "Can piece work be made to apply to track work, either maintenance or construction." Personally, I have never tried piece work on maintenance of track, but have had some experience along this line on improvement work. I do not think that the substitution of piece work for day labor would work to advantage in maintenance of track, for the reason that there is too much chance to slight the work.

A laborer on piece work is concerned only in getting over as much ground in one day as possible. If he can put over shoddy work on the foreman, he will do so. On the other hand, in day labor the laborer will try to make a job last as long as he can, thereby getting good work done.

The pushing forward of day labor is up to the foreman, and with a good foreman in charge more good track work can be accomplished for the same expense than by piece work. Piece

work will get work done cheaper (first cost), but the work will not be lasting. Regarding doing only certain kinds of track work by piece work, such as removing ties, laying rail, cutting weeds, ditching, etc., I would not like this for the reason that the regular section gang would have to follow the piece work gang and finish the work for them.

A section foreman should feel responsible for all track work on his few miles of track. Put everything up to him and he will give the different kinds of work equal attention. I have seen the proposition of two gangs working on the same section, each gang having only certain kinds of work to look after. As a roadmaster, I have had foremen on such sections give the excuse for passing up some work, which to leave undone was dangerous to traffic, that the other gang was supposed to look after that; that they had nothing to do with it. The two-gang section was a failure from the start. I feel that piece work would result the same way.

I had an experience with some improvement work on the piece work basis and the result was anything but satisfactory. The work was slighted from the start to finish, and the regular section gangs were compelled to go over all the work in order to make a good job of it.

The laying of rail by piece work would not work out, owing to the fact that it requires a large force to lay rail, and any one man cannot do the same thing all the time. If you pay on a basis of feet of rail laid, dividing the pay between the entire gang, some of the laborers will be dissatisfied on account of doing more work than others and getting the same pay. Of course this applies to day labor the same, but here it is up to the foreman to get the work out of the men. With piece work, he would not have the authority over his men that he would have on day labor.

Piece work would and does work excellently in some departments, but I do not think it would be a success in the track department. Another objection to piece work is that the bookkeeping on each gang would require more of the foreman's time than he could afford to give it and properly supervise the work of his men.

SUBSTITUTION OF PIECE WORK FOR DAY LABOR—NO. 3.

J. W. Newsom.

After reading so much in your valuable paper concerning section labor, I have become deeply interested in the subject. I have also been doing some studying and figuring, and also had some experience substituting piece work for day labor, and have come to the conclusion that piece work has its advantages in some repairs of track.

We all know that maintenance conditions are at a very low ebb now, worse than was ever known in the history of railroading. We have the worst labor because the pay for labor is so little.

I have never laid rail by the piece work system, but I believe we could use the plan successfully. Then we would have to have our gang of men properly organized, into different crews, which could be arranged in this manner:

1 general foreman.	6 men to spike.
1 assistant foreman.	2 men to adze ties.
2 flagmen.	1 man, spike and bolt peddler.
6 men to pull spikes.	
12 men to place rail.	3 men as nippers.
4 men to put on angle bars and full bolt.	1 water boy.

And if you use tie plates one (1) man to place tie plates. Of course we would pay the foreman, assistant foreman, flagmen and water boy standard salary by the day; pay the spike pullers, adze men, rail placers and spikers so much for every 30 feet; pay the strappers so much for every joint; pay the tie plate man so much per plate. A rate of pay could be gotten out that would be satisfactory. A plan like this would encourage the laborers and they would work with a vim, and that is what we need in the track department. I have never used piece work in track construction, but think we could use it to advantage.

But I believe a complete practical piece work system for maintenance of track could be worked out. As an example: On a section of track nine miles long have a foreman on standard salary, an apprentice on piece work, and six negro laborers on piece work. Here we usually put in between 25 and 35 ties, and surface about 125 feet per day of 10 hours, working the men by the day.

Now I believe we could do more work and better work if we used the piece work system.

Let us pay a certain rate for every tie put in, pay a certain rate for every 10 feet of track surfaced, pay a certain rate for every 10 feet of track refilled. Of course we would have different prices to suit the different kinds of ballast we work in, as a man can do more work in cinder ballast than in rock ballast, and prices would have to be arranged accordingly.

In my experience with piece work, in one day of 10 hours, two men put in nine ties each, spiked, surfaced up 35 feet of track each in rock ballast and refilled same, but did not shape up the shoulder; two men put in eight ties each, spiked, surfaced up and refilled 32 feet of track each in rock ballast; two men put in six ties each, spiked, surfaced up and refilled 32 feet of track in rock ballast. One of these men was water boy and went about 200 yards four times in a day for water. One man walked a quarter mile to tighten up bolts in a joint. The track where this was done was raised about 2 inches high, and it was 1¼ miles from headquarters. In this one day the piece work system showed a net gain of nine ties and 73 feet in surfacing track.

In this experiment I made this offer: To pay 8 cents for every tie put in and spiked, 3 cents for every ten feet surfaced, and 2 cents for every 10 feet refilled; so the two men made about $1.25 that day. You see they got pay for what they actually did.

In cutting grass we could use the piece work system all right, and pay so much a square yard for cutting. We could also use it in tightening bolts and regaging track. I think on section work we would pay so much a mile for cranking the lever cars, and in tightening bolts pay so much for every joint. Under the piece work system a track foreman would have to be on the job all right, but that is what is required of him.

SCREW SPIKES.

Editor *Railway Engineering:*

I have written the several roadmasters of the B. & M. R. R. and find only two have made experimental use of screw spikes. All are of the opinion that these could be only used to advantage on a road well ballasted. On this railroad a great many shims are used in the winter season, and with the use of screw spikes would be a very difficult matter to remove spikes to allow shims to be put in place. The general opinion seems to be that it is not necessary to use wood tie plug, but would recommend hole be bored just large enough to take body of spike.

(Signed) A. B. Corthell,
Chief Engineer Boston & Maine R. R.

Editor *Railway Engineering:* I would advise that up to this time this company has not made use of screw spikes. We are making general use of creosoted ties and may very likely be forced to adopt screw spikes to obtain the full use of the creosoted ties. I do not anticipate any trouble with their use on account of the track heaving and requiring shimming in cold weather, as at the present time there are few or no places on our line where shimming is resorted to during the winter weather.

In regard to the use of wooden tie plugs to receive the spikes, I have had no experience with them and cannot therefore, express a very definite opinion.

(Signed) Joseph O. Osgood,
Chief Engineer Central R. R. of New Jersey.

DECREASING AMOUNT OF LABOR THROUGH JOINT MEETINGS OF FOREMEN.

Andrew Palm, Roadmaster.

In this part of the West it is impossible under the present wage conditions to obtain other than foreign labor, which is generally supplied through labor agencies, and usually by agents of the same nationality as the men employed. We have considerable trouble in retaining men on account of contractors and others offering wage inducements from 35 to 50 per cent higher than we are paying; we can only retain the most ignorant and unintelligent of them, but as they come in squads or companies of five to ten we sometimes set two or three men of fair intelligence who will remain on account of looking after the welfare of the others.

Our forces consist of Greeks, Japanese, Mexicans and Hindus. The Hindus are a new proposition and seem to have a distaste for track work; they are leaving to take up other employment such as truck gardening and fruit raising. The Japanese are getting scarce; their government has restricted their emigration and those we now have are combining together to lease or buy fruit orchards or land for gardening purposes, and they are passing rapidly from track work; so the only cheap labor we can consider is Mexicans and Greeks, and they are a bone of contention to the foreman. Some of our foremen prefer the Mexicans while the others prefer the Greeks, but all admit there is little to choose between them.

We furnish our section forces with houses or combination cook and outfit cars; our extra gangs with outfit cars free of charge.

We give our outlying sections and extra gangs free transportation for their provisions and they are usually satisfied with this arrangement; under the conditions mentioned we get a fair average day's work from our men, but I cannot say that they make very efficient track men, for if the foremen do not keep a strict watch over them they are likely to slight or shirk their work. There are but few that can be trusted to work on their own initiative, and as a rule they must be taken to a job and shown how it must be done. The foremen must do this each time they are taken from one job to another, and few if any of them will ever make efficient foremen. At the best we can only use them as a makeshift.

You cannot accomplish as much in trying to drive them as you can by using diplomacy; the considerate foreman usually retains his gang and shows a better average in expenditure than the foreman who tries to drive his men and who, almost without exception, succeeds in driving his men away from the job.

There is always room for improvement in track maintenance, and roadmasters have at hand at all times a simple method of increasing track efficiency; that of asking questions. The foremen are the men on the spot. They are in direct charge of the work and if they have been trained along conservative lines, will have, or will find the best solution of any difficult proposition they or the roadmaster will go up against.

During the past year or two there has gone up a "hue and cry" for greater efficiency. The railroads are demanding it, and with the exception of the maintenance-of-way, all the departments are putting forth great effort to acquire it; it is true that we are supplied with heavier rails, better switches, etc., but while greater intelligence is required in all other departments we are not requiring nor seeking it in the track department; this department has been on a standstill for a number of years, and the signs of the times indicate that we must revolutionize our present system of using ignorant men, and employ intelligent labor.

Present day efficiency is a combination of practice and study, and to make efficient track men we must make students of them; but we cannot retain an intelligent man at a wage less than he can obtain elsewhere for his labor.

We all know that a young English-speaking track laborer is a more efficient workman after one or two years' experience, yet we pay him the same rate as we did on the first day he entered the service, then knowing absolutely nothing of the work. Look into all other branches of business and you will always find as a young man becomes more proficient his employer will give him a slight raise in salary; the young men are eager for advancement and by being thus encouraged will put forth greater energy to obtain it. I believe by using this same method we can induce our grammar and high school graduates to enter the track service and there is no doubt as to what the railroads would realize by adopting this method.

Under our present system there is vast room for improvement; such as systematizing the work, buying tools carefully, and in many other ways that could be mentioned. Let us look into the question of buying and the use of tools; in railroad circles it is the universal opinion that the most inadequate and cumbersome tools are the best and most fit for track use. I wish to make a few comparisons in the efficiency of track tools; one instance that came to my notice a short time ago occurred when a short spur was being taken up. Two claw bars of different make were in use for several hours one was pulling three spikes to the other's two; the bar that pulled the faster was worked by one man, while the other was used by two men, one holding the bar while the other used a spike maul to drive the claw under the head of the spike; and when the spike was partly drawn they had to use the maul as a heel for the bar. We changed the men on the bars, but the result was just the same. While there was but a slight difference in the price of the two bars, the ratio of efficiency was 3 to 1. Another instance—two machine track drills of the same make were being used on the same job, that of relaying steel rails; one was fitted with a round twist bit the other was fitted with a flat bit; the twist bits would bore from three to eight holes and then would have to be reground; the flat bits would bore from sixty-eight to ninety-two holes before they had to be taken out to be resharpened; the ratio of efficiency of the flat bit over the twist bit was in excess of 14½ to 1; the flat bit is quoted at a price less than the twist bit. Track chisels are purchased that are so brittle as to break with the first blow of a hammer; wood handles are purchased which are valueless. I have seen maul handles that were so brash that they would break off in the eye of the maul while being driven into it. Such economical spendthriftiness should not be countenanced by any railroad, and I doubt that it is in any department with the exception of the track department. Roadmasters and maintenance foremen should be consulted as to what tools foremen should be consulted as to what tools would be the most economical to purchase, this within my recollection, has never been done, but it can readily be seen that here is one of the most costly leaks in the railway service. It is very evident that the foreman should be consulted as to what tools are absolutely necessary to bring the best results; he is on the ground in direct charge of the work and is best fitted to judge the merits or demerits of tools furnished the track forces; this fact must be recognized: tools are just as conducive to efficiency as labor.

I would suggest that the superintendent and the division engineers once a year call the maintenance foremen into the division headquarters and confer with them as to what tools and supplies would be the most economical to purchase; have the agents of the different supply houses on hand with their goods which they wish inspected and tested and have them tested by men experienced in the work upon which the tools are to be used, and recommend none for purchase that do not pass favorably the inspection of these men.

As I have stated before, methods of handling track work have shown but very little progress for a number of years, and I would suggest that roadmasters have each foreman map out a system of maintenance, the roadmaster acting as an adviser; he will find as many different systems as there are foremen. Each foreman will have a number of good ideas, which, when consolidated into one system, will result in a great saving of time and labor and surely be very instructive to the roadmaster and others in charge of track maintenance. An instance came to my notice a short time ago. Some foremen knew how many ties were needed in each mile and they unloaded that number, throwing off a certain amount about one-tenth of a mile apart; every tie had to be reloaded on push cars and redistributed. I found a foreman with a note book in hand, in which he had noted how many ties were needed between each telegraph pole, calling to his men the right number and unloading while the train was moving at the rate of six miles per hour; this man saved hours of time by so doing. Therefore, I contend that it would be instructive both to roadmaster and foremen if they could meet at the roadmaster's headquarters once each month and compare methods of handling track work. Have each man prepare a paper on some subject vital to track maintenance. Some will be a little backward at first, on account of not being able to write as fluently as others, but by impressing upon them that it is the kernel of the nut we are seeking, not the fancy outer shell, they will take deep interest in the subjects and produce ideas that would prove extremely valuable in the elimination of lost motion and waste.

Another point I wish to mention (although it is not strictly pertinent to the point at issue). It is one of the direct causes of inefficient labor on track, this cause being the age limit of 45 years that railroads are imposing upon their employees. And they will not accept a man under 21 years of age. And although paying them a wage far less than is paid for the same class of labor elsewhere, we demand more from them than is demanded of them where there are no restrictions other than requiring them to be able to accomplish that which they are employed to do. A laborer or foreman is more valuable to a railroad at 45 years of age than a younger man, as his knowledge and experience is such as to make him more conservative in his methods of handling work. He will give each subject careful thought, saving dollars to the railroads, where younger men by using snap judgment would be wasting them.

PIECE WORK SYSTEM IN THE M. W. DEPARTMENT.

W. A. Trimble.

It is only fair to those who favor a piece work basis for the maintenance of way department to admit that this practice has never been used generally on our road, therefore we arrive at our conclusions from some few experiments that have been conducted to ascertain whether or not the system would be successful. And we find that it could not be used to advantage on important main line divisions. We estimate the cost of putting in cross ties as 25 cents per tie. Included in this is cost of delivery, taking out old tie and piling same for burning or removal by work train, installation of new tie and first tamping. While many supervisors and roadmasters contend that this is high, we find that this is the average cost, and if ties are put in for less money, under traffic, it means that the work has not been done in a careful workman-like manner. Assuming that a section gang of twelve (12) men can put in 100 ties per day at a labor cost of $19.70 (rate $1.65 per day per man), and add to this amount $5.30 for work train delivery, including cost of engine, crew, etc., we find that the average for the day's work is 25 cents per tie. Take the same 12 men and have them understand that they are working on a piece work basis, they will perhaps get a larger number of ties in, but it will be found that the digging out, under or in the bed of the old tie was not as carefully done as it should have been. The spiking shows that the spikes were not properly set before being driven home, making it necessary to bend them over by a blow of the hammer, so as to engage the rail, and in this bending process the wood fibre has been destroyed to such an extent that the water will find its way down the spike hole, causing rust of spike and decay to tie, to say nothing of labor and expense soon necessary on account of regaging. The ties would be poorly tamped, making resurfacing necessary within a very few days.

A matter so important as tie renewals should never be done by piece work or contract, but by men to whom the foreman can explain its importance, and insist that it be done right regardless of number of ties put in for a day's work.

It would be hard to arrive at or establish a system whereby such work as cutting weeds and mowing could be done by piece work, inasmuch as it would be necessary to pay a certain sum for a given plot, and to do this systematically would necessitate a careful measurement or survey to do work of this nature on a basis other than the regular "day man." It would seem that the "contract way" would be most profitable; that is, take a certain slope or lawn and tell the men that so many hours' time would be given them when work is completed, providing, of course, that it be well done. A foreman giving work out by contract must be a tactician, and must be prepared to let the men go home upon the completion of the task, regardless of the fact that the work may have been done in half the time he expected it would require. To do otherwise will lead to discontent among the men, especially the foreign element.

I do not see that track laying or relaying could be done by piece work to any advantage, nor do I think it should be permitted, as the work is so important that it should be done in the best and most competent manner and not hurried in any way, as would unquestionably follow the advent of the piece work system.

The laying of rail by piece work would be impracticable and if results would not be unsatisfactory to roadmaster or supervisor, it would be to men, because: (1) If exclusive use of track during the operation be obtained, the rail would be laid in such a hurry that expansion would not be given proper attention, and ties would not be properly adzed to prevent canting; in other words, the men would take advantage of having exclusive use of track and try to make a big day's wages, and I believe, in the end, the track structure would suffer regardless of the fact that the foreman might be vigilant in the discharge of his duties; (2) at times when it would be impossible to get exclusive use of the track, which is quite often the case, in fact generally on main line divisions, so few rails can be laid that it would be impossible for men to make a rate equal to the very low wages which they now receive, while at times when they had the track without interruption, the wages of the men would exceed that of the foreman or skilled laborer.

There can be no doubt but foreigners (who compose to a large extent the personnel of the track forces) are greedy and avaricious and would have at heart only the making of large wages, regardless of the efficiency with which the work was performed.

Further, it would be a great task to arrive at a standard rate for the performance of the many items of work, such as laying rail, tie renewals, line and surface, driving spikes home after constant vibration of trains had caused them to work out, tightening bolts, renewing nut locks, etc. The personal supervision of the foreman would be doubly necessary to insure good work, so much in fact that he would have to be relieved

of keeping time, charging out rolls, proportioning the earnings of the gang to the several men in the gang; and the reports which would be necessary would be so difficult that the average foreman could not handle them and it would be necessary to employ a clerk for each and every section gang, which would greatly increase the operating expense of the road.

Lastly, we must consider the important matter of safety. The various railroads have started "Safety First" movements, and the conservation of human lives is the first consideration; and even now, when the men are warned they will be disciplined when they do not get out of the way of trains sufficiently in advance of the arrival of the train so as not to make it necessary for the engineman to sound the whistle, we still have trouble in getting them to get clear of tracks as promptly as they should. If it is difficult to get the men to step clear of tracks when they are paid for the time they lose, is it not fair to presume that it would be very much harder to get them to do so if every minute they lost during the day would be deducted from their day's wage, as would be the case with the piece work system?

Whether or not this system could be used to any advantage would have to be demonstrated by an actual test, and I believe it would be possible to make such a test on one of the western roads, but believe even a test would be impracticable on the eastern roads, where the traffic is so very heavy and where heavy grades and sharp curves make trackwork so difficult.

ACCEPTING APPLICATIONS FOR POSITIONS IN MAINTENANCE OF WAY DEPARTMENT.

E. W. Miller.

It has been the aim of the maintenance of way departments of all railroads to procure the best workmen, and as a result the best work possible, in order not only to maintain safe conditions but also to give their road a reputation for comfortable traveling, which is one of the primary factors in the success of a railroad company.

Competition in the railroad business demands that every department exert itself to its fullest extent to obtain the best results with the least possible expenditure, and many experiments have been the result of this demand.

In order to make a success of any department, great care must be taken in the appointment of the heads of that department and their immediate subordinates.

These men in most cases receive and consider applications for positions in their department and unless they have a knowledge of character as imprinted on the applicant's face and conduct, in many instances trouble and inconvenience are likely to be the result.

For instance, if the division engineer or supervisor should receive an application from a man whom he has never seen and about whom he knows nothing, in what way will he determine whether that man is the man he needs for that one particular vacancy? The information regarding past employment will give him some knowledge of the applican'ts ability, but unless those statements are investigated there can be no real knowledge of the man, and this investigation costs time and money.

This condition makes written applications preferable because of the liability of complications arising, in which case the written application can be used as reference and a permanent means of verifying the applicant's statements. But even this is but one view of conditions in obtaining workmen. If the division engineer or supervisor is a student of character a great deal of trouble and work will be saved. In most cases the character and habits of a man will imprint itself on the face and conduct of that man, and a student of character will be able to read his face like an open book, and if he sees anything that reveals habits detrimental to his ability to fill any particular position competently, then he can dispense with investigating the application and throw it in the waste paper basket, but if the face is one that shows a steady mind, willingness, ambition and integrity, he is safe in employing this man and the applicaton can be investigated subsequently.

As far as the applicant's ability is concerned, the written application is indispensible, but when character is to be taken into consideration, the face is a more reliable informant than references can possibly be.

Great care should be taken in selecting a foreman for a section gang. In the first place a foreman must have a thorough knowledge of the work he is to superintend. Many things arise during the day's work, a superficial knowledge of which would not suffice, and would undoubtedly lead to mistakes and perhaps accidents, and as a result would probably cost the company much more than the man's position is worth.

A foreman should have a knowledge of the men with whom he is to deal, know how to get the most work out of them and how to prevent disagreements which are liable to arise.

Besides these qualities he must be an economical manager, exerting himself to minimize the expenditures of his department in the maintenance of the track.

Experience has taught that, though labor can be secured through the employment bureau, in the maintenance of way departments of railroads personal applications are the more desirable.

The problem of the comparative value of domestic and foreign labor must be taken into consideration in this connection.

There has been great trouble in solving this problem on account of the lack of domestic laborers who will undertake such work as this department necessitates, and as a result foreign labor must be accepted in order to do the necessary work; but I have found that as far as is possible, domestic labor is far the more satisfactory.

The Baltimore & Ohio has awarded contracts for the construction of passenger stations at Walkerton and Syracuse, Ind. These will be of pressed brick with red tile roofs and will cost respectively $10,000 and $13,000.

The Canadian Pacific has purchased 7 acres of land at Galt, Ont., Can., and expects to erect buildings for terminal facilities at this point. It is planned to make a junction there with the Lake Erie Northern from Port Dover, of which Galt is the northern terminus.

The Chicago, Burlington & Quincy will build a new station at Canton, Mo., and has plans for a similar structure to be built at Shelbina, Mo.

The Chicago, Milwaukee & St. Paul is reported to be planning new yards at Bass Lake and also at Montevideo, Minn.

The Illinois Traction, it is reported, will erect a 7-story passenger station and terminal at Peoria, Ill., within the near future at a cost of $350,000.

The Kansas City & Memphis will construct a bridge over the White river, near Monte Ne, Ark.

The Louisville & Nashville, it is reported, will erect a passenger station at Pineville, Ky., to cost approximately $100,000.

The Michigan Central, it is reported, will erect a new machine shop and power house at St. Thomas, Ont., at an estimated cost of $150,000.

The Missouri, Kansas & Texas is constructing a new passenger depot at Taylor, Tex.

The New York Central & Hudson River will take bids April 4 for 2 bridges at Otis, N. Y., 1 at Forest Lawn, N. Y., and for some grade crossing work at Gurderland Center, N. Y.

With The Manufacturers

IRONITE WATERPROOFING.

Ironite waterproofing is a material which depends for its value on the chemical reaction after it is painted on the surface to be waterproofed. The material is in the form of an exceedingly fine metallic powder, having no oil, paraffine, asphalt or other similar substance incorporated in it.

This powder, the manufacturers state, oxidizes, and when mixed with water and painted on concrete, stone, brick or tile surfaces, presents a solid and continuous metal surface that is impermeable and not affected by heat, cold or water. A recent test was made by Bertram Blount, F. I. C. of London, England, on a number of test pieces coated with ironite waterproofing. He concludes as follows after examining the pieces subjected to test:

"The action of 'Ironite' depends on the material when exposed to air and moisture undergoing a simple process of oxidation. The products of this oxidation are stable substances which, having reached conditions of equilibrium, are unlikely to undergo further change by continued exposure to ordinary agencies. On account of the stability and inertness of the 'Ironite' after it has become oxidised and has completed its work, it is not capable of causing any injurious action on the structural materials with which it is in contact. Its waterproofing qualities are sufficiently demonstrated by the various severe tests which are recorded in the present report, and its power of acting as a cement is an additional advantage in many cases. I am of opinion that 'Ironite' is a material of great value for rendering structures water-tight and making porous surfaces impermeable."

Tests were also recently made on this waterproofing substance in connection with a number of others by the United States Government Bureau of Standards, and it is stated that Ironite was the only compound out of 26, which passed all tests successfully. Ironite may be applied on either surface of a wall, but is usually applied on the inside of basement walls. The action is not similar to a membrane coating, but the substance, it is claimed, forms a combination with the concrete and penetrates to some depth into it.

M. J. Eggleston, Karpen Bldg., Chicago, is railway sales agent for this material.

Industrial Notes

Among others who were imparting words of wisdom at the Coliseum and elsewhere during the Chicago convention were H. S. Mann and A. F. Braid, of the Goldschmidt Thermit Co. The subject closest to their hearts was "Carbon-free ferrotitanium for rails."

The Western Wheeled Scraper Co., on account of greatly increased business and prospects of a repetition of former prosperous seasons, has built and recently put into operation a large new power plant. An addition is also being made to the car shops, which will greatly increase facilities for manufacture, assuring better service to customers.

The Universal Portland Cement Co., a subsidiary of the United States Steel Corporation, has started work on the construction of a plant at Duluth, Minn. This plan will cost about $1,700,000, and will have an ouput of 1,400,000 barrels of Universal Portland Cement per annum. The plant will be electrically operated throughout, requiring about 500 horsepower.

The Columbus Railway Supply Co., Columbus, O., has been incorporated with a capital stock of $10,000. George A. Johnson is prominent in the organization.

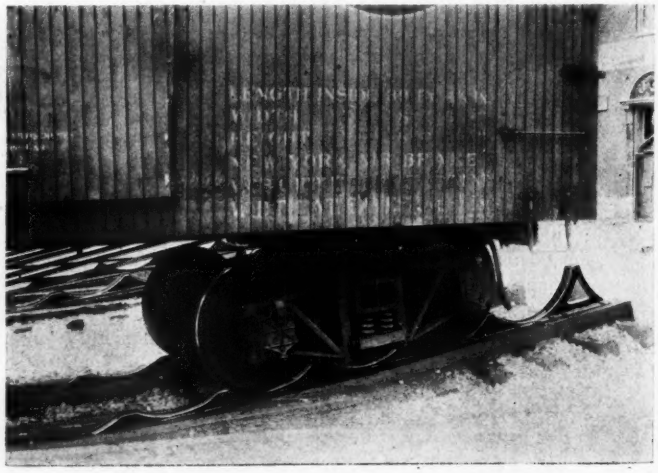
C. J. Morrison has resigned his position with Suffern & Son, and with others has organized Froggatt, Morrison & Co., 149 Broadway, New York, efficiency engineers.

George W. Greene has been appointed resident manager for Morgan T. Jones & Co., with headquarters at 213 Wabash building, Pittsburgh, Pa.

The Des Moines Bridge & Iron Works, Des Moines, Ia., has secured a contract from the Canadian Northern Ry. for watef tanks and towers for the new line from Lethbridge, Canada, to the Pacific terminal of the line. The amount involved is about $250,000.

SAUNDERS CAR STOPPER.

No matter how meritorious the article may be, railway officials are slow to change from established practice and adopt any device that is a radical departure from those which have proven dependable under all stresses and strains. This has been the experience of the Southern Railway Supply Co. in marketing the Saunders Car Stopper, due in part to the fact that it appeared too simple to be effective, and whether or not it was effective could only be determined by long-time service. It has passed through this period of probation now, however, and is recognized as an extremely practical device, as is evidenced

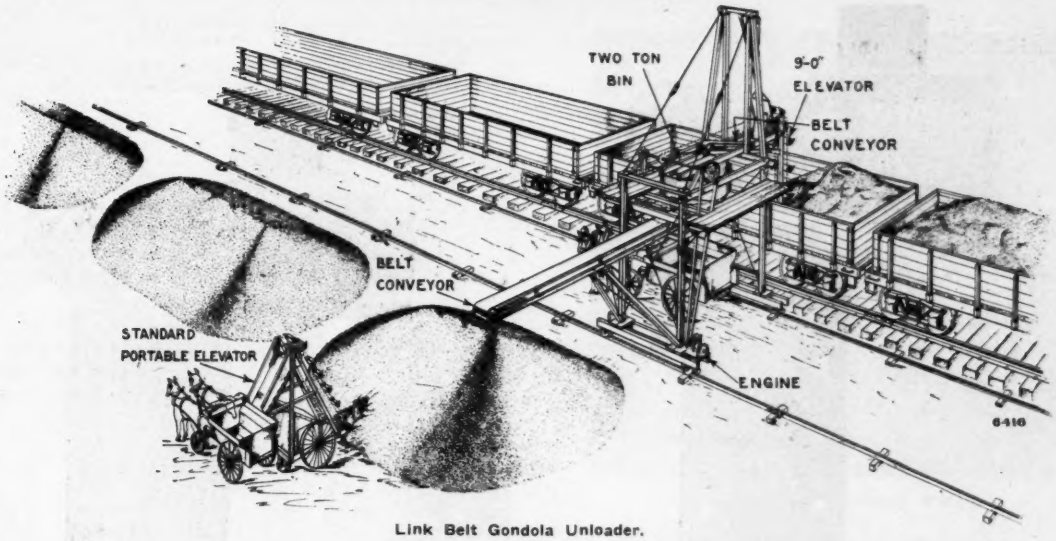


Freight Cars Stopped by Saunders Car Stopper.

by the constantly increasing orders being received by the manufacturers.

One of these stoppers was installed on one track of a two-track siding, the other track being equipped with a bumping post. To unload from the cars to advantage it was necessary for the rear car to engage the stopper, as also the bumping post. The upkeep on the Saunders Stopper for one year amounted to $4, and on the bumping post over $60, which gives a fair indication of the very slight damage possible even under the most severe service.

The principle involved in the Saunders Stopper is scientifically accurate—as soon as the wheels of a car strike the stopper the flange engages it instead of the tread, increasing the ratio of braking resistance, on account of the larger circumference of the flange, and as it enters each corrugation successively this resistance increases. In addition to its effectiveness, the Saunders Stopper is considered attractive and sightly and an ornament to passenger terminals and yards.



Link Belt Gondola Unloader.

GONDOLA UNLOADER.

A very effective device for cheapening the unloading of gondola cars has recently been perfected by the Link Belt Co., Chicago.

A demand has been felt for a machine which would unload coal, gravel, sand, etc., from gondolas, and do it efficiently, economically and effectively. Such a machine must be thoroughly dependable, as delay in loading and delivering material means loss. When delivering material for concrete, a delay may mean stopping an entire gang of laborers.

The loader illustrated beneath has a bucket elevator which descends into the car, digs the material, and delivers it to the belt conveyor or to a storage hopper; the hopper is used for loading carts and wagons, and the belt conveyor delivers the material for ground storage.

A type D bituminous loader is shown loading the material into a wagon. This loader works equally well in stone, sand, gravel, etc. With this portable machine it is possible to load a 5-ton truck with coal in about five minutes. Crushed stone can be handled at the rate of 35 to 40 tons per hour.

The Link Belt Co. has been very active in meeting the demands for loaders and unloaders, and the large number of different types designed by them will fulfill almost any requirements for machines of this character.

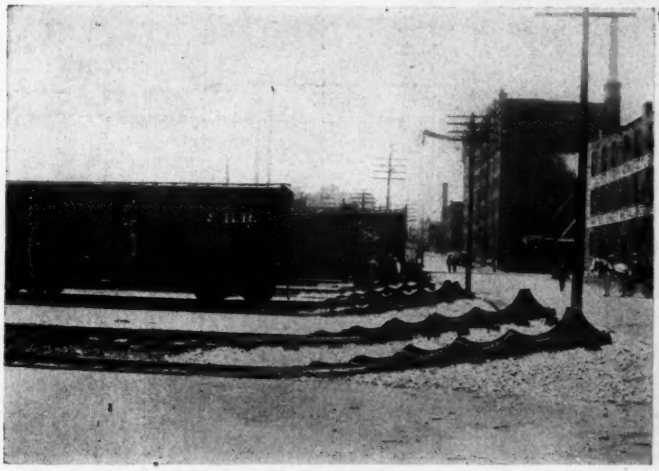
LIGHT WEIGHT VELOCIPEDE.

On many lines equipped with block signals the passenger trains are flagged through short-circuited blocks by the assistance of light weight "speeders" or velocipedes. In the use of the speeder, the rule usually allows the flagman a five-minute start, and the train follows under control. The time saved by the speeder where blocks must be flagged is thus quite considerable.

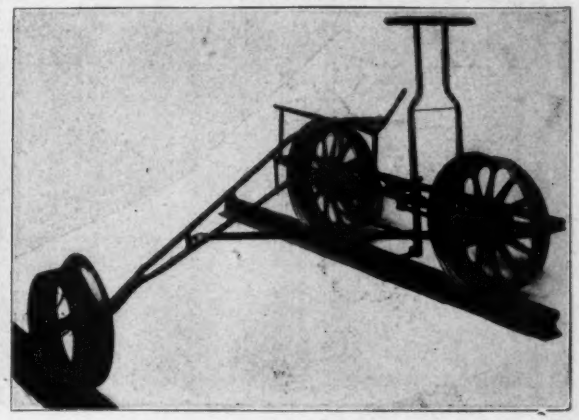
The velocipedes for this adaption must, of course, be light in weight and easily folded for storing in baggage cars. They must be capable of quick assembly when occasion for their use develops; and they must furthermore be highly geared for short fast spurts. In order that they may not interfere with signal circuits they are insulated from rail to rail.

The illustration shows the velocipede designed by the Kalamazoo Railway Supply Co., Kalamazoo, Mich., for this service. It weighs 100 pounds and the framing is built of light channel section. The castings are of steel and spring steel is used where stiffness as well as lightness is desired.

In case of accidents when it is necessary to send a flagman back to flag a following train or ahead to run short circuited blocks, it is almost indispensable. Although the manufacturers designed this velocipede especially for an emergency car, a great many roads have found it very useful where a light, speedy machine is wanted, in fact, a great many signal men have purchased this car for use in getting back and forth over the line where there is no great load to be carried.



A Row of Saunders Car Stoppers.



Kalamazoo Steel Frame Velocipede.

Fig. 1.—Hercules Ball Bearing Door Hanger.

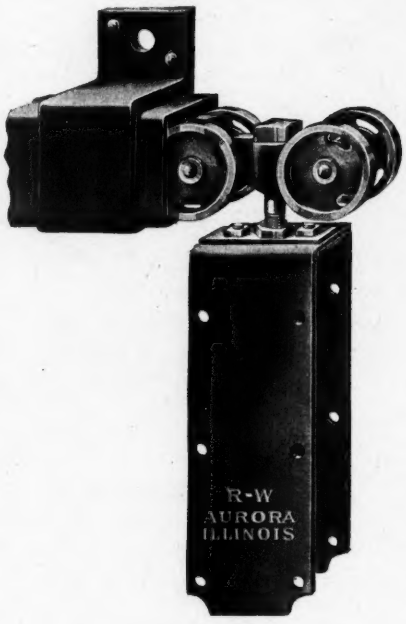


Fig. 2.

EXHIBIT OF RICHARDS-WILCOX MFG. CO.

One of the most attractive exhibits at the Coliseum during the American Railway Engineering Association convention, March 18 to 21 inclusive, was that of the Richards-Wilcox Mfg. Co., Aurora, Ill. This company manufactures the R-W trolley door hangers and track for single and parallel doors. It also makes a complete line of tubular track door hangers, underwriters' approved fire door fixtures, overhead carrying systems, parallel door hardware, rolling ladders and mounted grindstones.

The principal feature of the exhibit was an interesting installation of doors arranged in bays as in service in railway freight houses, warehouses and the like. Some of the articles forming the exhibit are described below:

"A Hanger for Any Door That Slides."

Figures 1 and 2 show the design of two door hangers which are prominent among those types made by the company in living up to its slogan: "A Hanger for Any Door That Slides." These hangers are practically alike in construction, except that the one shown in Fig. 2 is made of heavier material, as it is used on doors weighing up to 1,000 pounds. Figure 1 is for use on doors weighing up to 600 pounds. Both have forged steel yoke, hardened bearings, lateral and vertical adjustment. The "Jumbo" hanger is adjustable for doors 2¼ to 3½ inches thick, has a double apron 12 inches long, 3½ inches wide, ¼ inch thick. The wheels are 3 inches in diameter. The track can be attached to side or ceiling supports. The "Hercules"

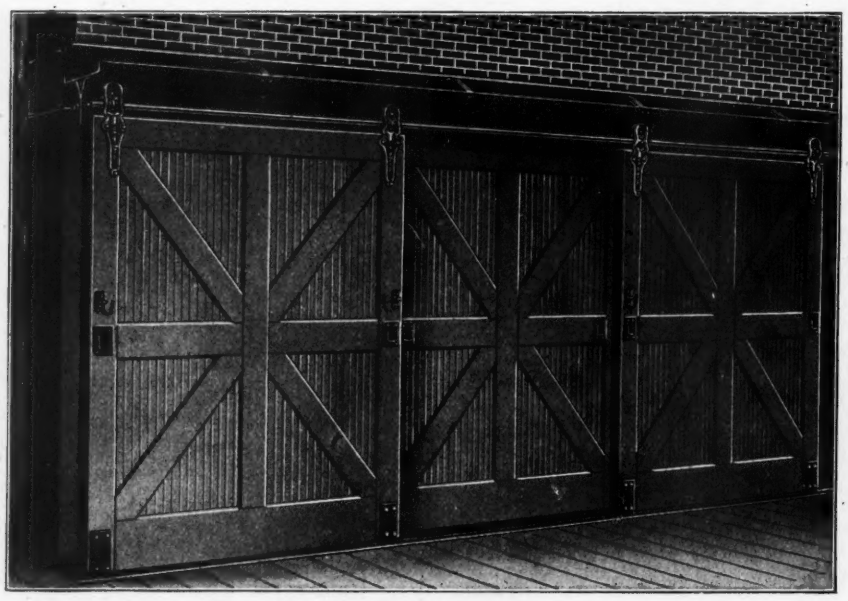
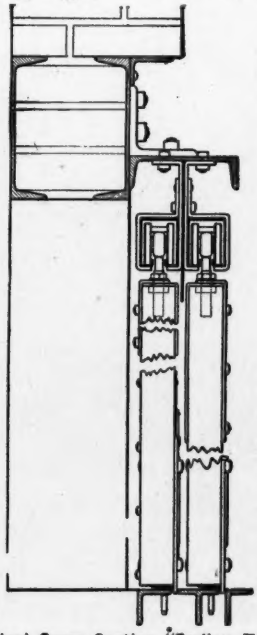


Fig. 3.—Parallel Door Equipment, "Trolley Track Type."



Vertical Cross Section "Trolley Track Type"

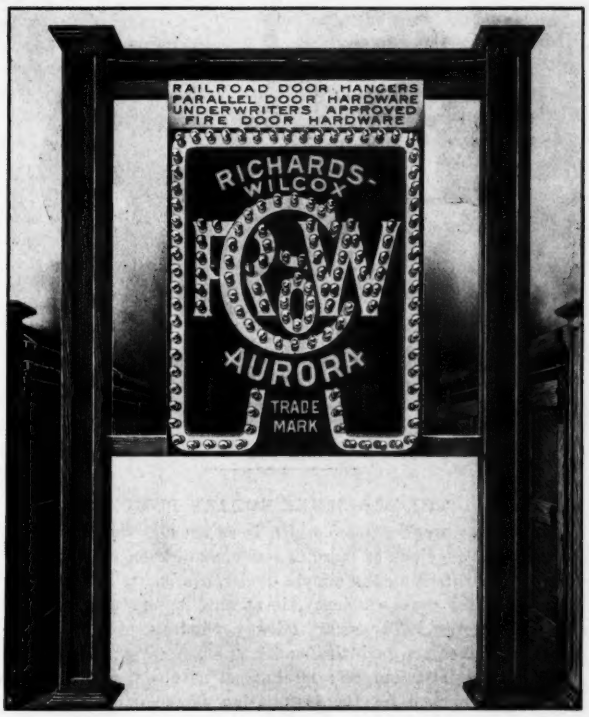


Exhibit of Richards-Wilcox Co., Chicago.

hanger is adjustable for doors 2¼ to 3 inches thick. The wheels are 3 inches in diameter. A pair of hangers consists of two hangers and carriers, one center and two end brackets, lag bolts for brackets and bolts for hangers. Track is furnished in any length up to ten feet, in one piece.

Parallel Door Equipment.

The Richards-Wilcox system of parallel doors for freight houses and warehouses, where unrestricted wide openings are desired, are made with either trolley tracks or tubular tracks. These doors have provision for both vertical and lateral adjustment and the trolley tracks type is shown in Fig. 3.

In freight house installations they are particularly desirable as their arrangement allows of an opening opposite the car entrance, no matter what the location of the car.

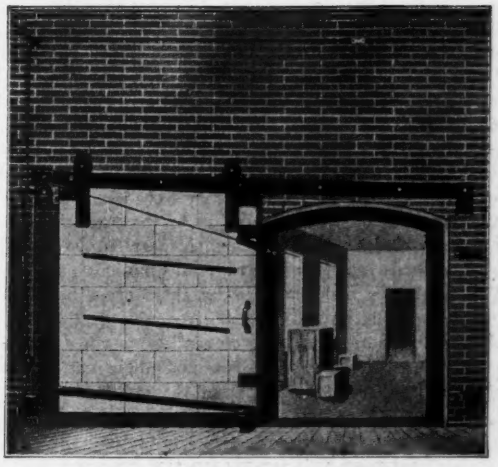


Fig. 5. Monarch Fire-Door Fixture.

Fire Door Equipment.

The fire doors and fixtures made by the Richards-Wilcox Mfg. Co., are styled the "Monarch." Figure 5 shows this door as mounted in conformance with the requirements of the National Board of Fire Underwriters. The doors are hung on either flat or tubular track and with either one or two links.

PAINTING OF CARS is not always given the attention that it should. It is easier to paint cars in the summer, but it is hard to get hold of the cars at that time. As a consequence many cars do not get painted at all.

An Installation of Richards-Wilcox Parallel Doors.

EUREKA PRODUCTS.

The true test of merit in any manufactured article is the length of time the product endures in the face of competition and changing conditions. Judged by this standard, no better recommendation for the line of paint and enamel specialties made by the Otley Manufacturing Co., Chicago, which they have aptly named "Eureka," can be given than to record the fact that this company was organized by the father of the present owners in 1875, and that they have adhered consistently to the same line of manufacture up to the present time, keeping pace with the changing conditions called for by the advanced methods introduced in railroad practice.

The specialties manufactured by them are all adaptable to railroad use, and include locomotive joint and iron cement, bridge and structural steel preservative coatings, freight car paints and lubricating graphites, and their entire time and energy is directed along this line of thought.

MUDGE-ADAMS HANDCAR ENGINE.

The constantly increasing demand from railway section foremen for a power car, and the growing tendency to convert old handcars into motor cars by the application of a gasoline engine, has influenced Burton W. Mudge & Co., of Chicago, to design an engine equipment to fill this need.

The Mudge-Adams engine, which has become known on the American railways through its use on the Mudge-Adams inspection motor car, has been fitted with the necessary base and pulleys to connect it up to furnish power for a handcar.

This engine equipment should prove popular because repair parts are interchangeable with the inspections cars.

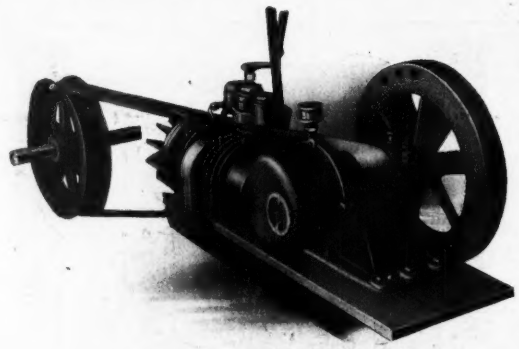
Power cars for use in railway work are proving a great factor in the saving of both time and money. Motor cars of the inspection and section type have been tried out on many of the railroads and their practicability has been demonstrated beyond any possibility of doubt.

Many railway men, realizing the benefits of a power-driven car in connection with their work, are equipping their old handcars at their own expense with gas engines, thus enabling them to cover more ground and do better work than was before possible.

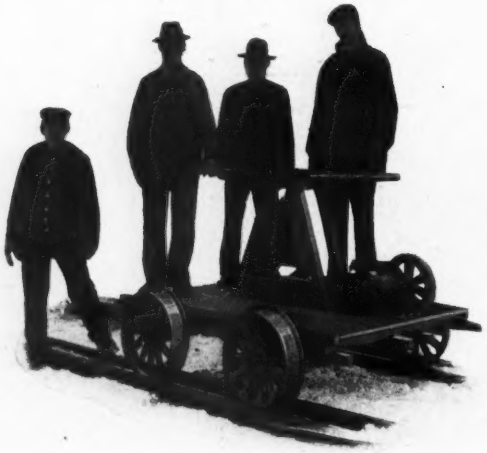
The Mudge engine is of the 2-cycle, air-cooled type, 4 H. P., and is reversible, thus permitting the car to be run either forward or backward.

One of the chief points of favor with the Mudge engine is its absolute simplicity. Every complicated mechanism has been eliminated, there being only three moving parts.

The installation of the engine is also very simple and can be accomplished by anyone without trouble or the use of special tools, in about two hours.



Mudge-Adams Hand Car Engine.



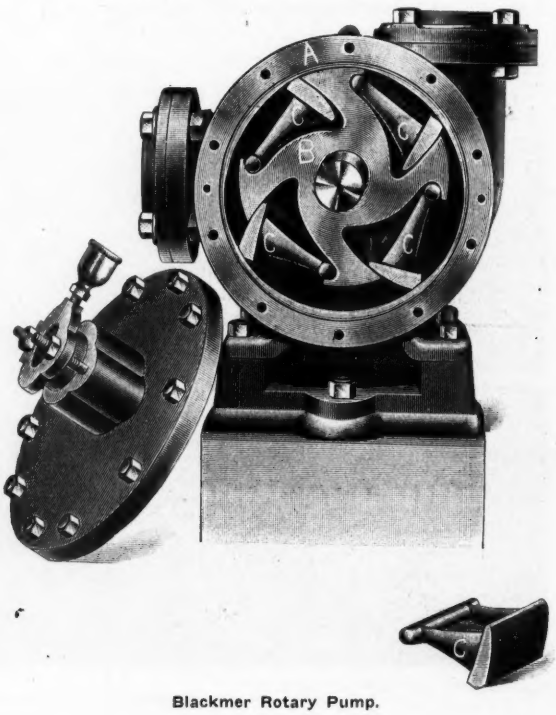
Mudge-Adams Engine Installed on Hand Car.

THE BLACKMER ROTARY PUMP.

In railway work a pump which is of unusual simplicity takes precedence over one of more or less complication in its mechanism. If in addition the simple device has on its side a proved argument for great efficiency, it at once becomes an object of special interest. The small railway pump is usually isolated from machine shop facilities, and it is often operated by persons without special talent of a mechanical nature, hence the officer cannot be blamed for the installation of the pump, which has for its recommendation great simplicity. The combination, therefore, of even a fair efficiency is worthy of note.

The illustrations show a pump made by the Blackmer Rotary Pump, Power & Manufacturing Co., of Petoskey, Mich. This pump is of the rotary class, but it embodies many new features which, while not complicating the construction of operation, have given increased efficiency. It may be installed with either gasoline engine, motor or steam engine drive and may be belted or direct connected.

The buckets are detachable and are arranged to take up automatically all wear, and after the buckets themselves are worn



Blackmer Rotary Pump.

down to a minimum they can be replaced by a simple operation and at slight expense. The manufacturers have made a principle of supplying the parts at the proportionate cost of the assembled whole. The pump handles either light or heavy fluids with equal facility. Where the wear is expected to be heavy, the pumps are supplied with lining discs which may be replaced as desired, thus preventing any wear on the casing. The pump may be taken down or assembled without the use of any special tools.

SWITCH PADLOCK.

We illustrate herewith the Miller Lock Co.'s No. 26 padlock, which has a bronze case and shackle, all brass interior parts and eight brass secure levers. It is claimed to be positively non-pickable and can be furnished in unlimited key changes under a master key; in other words, these locks can be made all different, each service controlled by a different master key from any other service and a grand master key to open all the locks over the entire system of a railway, no matter how large a quantity of locks are used.

The padlock is made with a steel corrugated key or a corrugated hollow or barrel key. It has been specified by a large number of penitentiary wardens as the only lock in which they

Miller Padlock.

could place their confidence. It can be furnished with a patented device which will permit the key to cut the ice from the tumblers when the lock is frozen, and is said to be the only lock manufactured which is sure of working at all times and under all conditions.

The Miller Lock Co., Philadelphia, which manufactures the lock described above, also manufactures the "Champion" 6-lever padlock with which many are familiar on account of its extensive use.

New Literature

The C. H. & E. Manufacturing Co., Milwaukee, Wis., has recently issued an attractive catalogue. The booklet contains illustrations of a number of devices manufactured by this company, and on the page opposite each photographic reproduction is an artist's drawing illustrating the proper use for the machine. Two colors are used, and the entire catalogue is gotten up in an artistic and instructive manner. The machines described are: C. H. & E. No. 1, 3 H. P. portable saw jig; No. 3, 4 H. P. portable saw jig; N. 1-A 5 H. P. portable saw jig; No. 2, 6 H. P. all iron portable saw jig; tilting table wood saw; power-driven diaphragm bilge trench pump; power-driven manhole pump; power-driven centrifugal pump; engine-driven 4 to 6 H. P. double acting builders' hoist; motor-driven 5 to 15 H. P. double acting builders' hoist; double cage material elevator; mortar mixer, concrete chutes; stone heater; tar kettle; and water-cooled gasoline engine.

* * *

The Link Belt Co., Chicago, has recently issued Book No. 170, which is confined to descriptions of a number of different types of wagon loaders. They are for loading sand, gravel, crushed rock, coal, etc. Several different types are illustrated and described, all of them being collapsible and therefore very easily portable.

* * *

"Railroad Motor Cars" is the title of an exceptionally distinctive and attractive appearing catalogue, designed and gotten out by the Sales Service Co. for Burton W. Mudge & Co., Chicago. A distinctive style of type is used throughout the book, which is printed on a quality of paper which makes the illustrations show up excellently. A standard border, consisting of a telegraph wire line and poles, is used on each page. The first few pages after the title page are devoted to the motor inspection car, showing its possibility of counteracting the tendency towards higher expenditures for maintenance. At the bottom of each page is an artist's drawing, depicting the various uses and conditions which the Mudge-Adams motor cars fulfill.

On page 6 are given the specifications for a class "E. I." 4 H. P., 4-wheeled inspection car. Several illustrations show this car, and its details. Pages 8 and 9 show this car, and describe the operation of same under different conditions. Following this is a description of classes "F. S." and "F. H." 8 H. P. section cars. Specifications for this engine and car are also given. These cars are for the use of section gangs, bridge and signal gangs.

Two new classes of motor equipment have recently been developed by this company, consisting of a horizontal engine, class "E. Q.," for applying to section cars, the size of the engine and all parts being the same as is used on class "E. S." section car, a newly developed product; thus the hand car engine can later be installed on the class E. S. section car if desired. The "E. S." car has provision for the addition of a second cylinder where greater power is desired.

The remainder of the catalogue is devoted to combination section and spike-driving cars, with descriptions of the various apparatus and parts.

COMBINATION BOILER TOP-FEED CHECK VALVE AND BELL STAND.

The advantages of feeding locomotive boilers at the top instead of the side have been urged for years by many who have found the practice satisfactory. On the Canadian Northern Railway, the top-check valve is double and is combined with the bell stand.

The feed enters the hollow sides of the bell stand through a vertical check valve, passing on through the hollow base into the boiler. Duplicate sets are arranged on each side. An emergency valve is supplied on each side between the main valve and the boiler, both emergency valves being horizontal, alongside of the boiler connection. The bell stand is also provided with a plug in the top for washing out the boiler. It is attached to the boiler top by a flange with a loose ball ring intervening.

This method incidentally does away with the danger of freezing always present with the conventional arrangement in severe weather. With this new arrangement the feed pipe rises on a gentle slope to the bell stand, where there is an outside check valve in addition to the one in the casting.

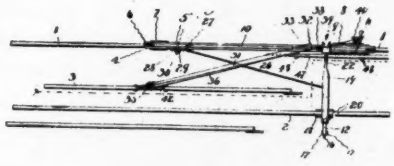
Recent Engineering and Maintenance of Way Patents

RAIL RELAYING MACHINE.

1,056,096—J. P. Haddix, Merna, Neb.

In a track-laying machine, a frame comprising a sill, wheels journaled thereon and adapted to travel on one of the track-rails, a mast erected on the sill, a swinging beam also mounted on the sill, a transverse beam secured to said mast, a brace-bar secured to the transverse beam and adjustably secured to the mast, a rod secured to the transverse beam, and a wheel journaled on the rod and slidably mounted thereon, the wheel being adapted to travel on the other track-rail, substantially as shown and described. The wheels are double flanged and this arrangement with the wheel movable transversely on its axle, gives a car which will run on practically any gage track. When relaying, the machine will run on old string rails which has been moved out.

1,056,096



EXCAVATING APPARATUS.

1,056,268—J. G. Fairbanks, Marion, O.

In an excavating apparatus, a pivoted arm, a bell crank pivoted to the arm, a dipper carried at one end of the bell crank, a traction means for swinging the bell crank, a pivoted gate arranged to move along the dipper, bridle means for holding the gate during the swinging movement of the dipper and means for limiting the swinging movement of the dipper with relation to the gate.

ELECTRIC BLOCK SIGNAL.

1,056,402—W. J. Cook, assignor to the Cook Railway Signal Co., Denver, Colo.

A railway signaling apparatus, comprising signal stations arranged along the track, each station including an electric signal located on each side of the track, electro-magnetic means for closing the circuit of each signal at each station, means for automatically locking each signal circuit in the closed position, electro-magnetic means for releasing the locking means of each signal circuit, circuit make and break devices arranged along the track on each side thereof and adapted to be placed in the closed position by a passing train, and circuit connections between the track make and break devices and the electro-magnetic means of the signal stations, whereby when a track circuit make and break device on one side of the track is closed the electro-magnetic means for closing the circuit of the signal on one side of the track at the home station is energized, while the lock-release electro-magnetic means of the signal on the other side of the track at the same station is energized, and the circuit connections also releasing a signal that has been set in the rear of the train and setting a signal that has been released in front of the train, substantially as described.

SWITCH RAIL.

1,056,470—E. N. Strom, Assignor to Pettibone, Mulliken Co., Chicago.

In a railway switch, the combination of a point-rail having the rail-web and inner base-flange expanded to recess the rail along its inner side.

REINFORCED FENCE POST.

1,056,515—J. H. Downs, Jersey City, N. J.

A fence post comprising an angle iron post consisting of two joined legs and adapted to be driven into the ground, a pair of separate reinforcing plates disposed adjacent each other and closely following the inner faces of the angle formed by both legs of the post above and below the level of the ground line when the post is set up, the plates being of different lengths and having beveled portions formed integrally with their upper and lower ends, the longer plate being positioned with its inner endge abutting against the face of the adjacent leg of the post, and the shorter plate being positioned to abut on the outer face of the first mentioned plate, the beveled portion of the shorter plate terminating at the ends of the straight portion of the longer plate, whereby mitering and pocket formation of their inner endges is avoided, also means for holding the plates fixedly in place when the post is driven into its assigned position.

GUARD RAIL CLAMP.

1,056,707—P. W. Moore, Assignor to the P. & M. Co., Chicago.

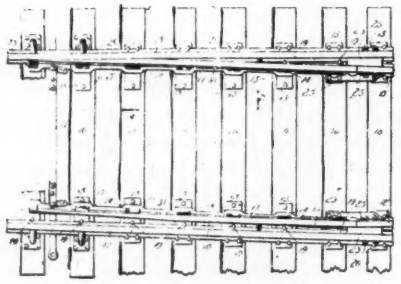
A guard rail chair having a base plate adapted to support a main rail and a guard rail, the latter having a portion of one flange removed to provide a clearance between the bases of the rails, thereby giving access to an opening in the base plate and permitting adjustment of the rail toward and away from each other without covering the opening, a jaw formed integrally with one end of the base plate for gripping one flange of the main rail, a sliding block mounted on the other end of the base and fitting against both the base and the head of the guard rail to brace the same, ways in which the block is guided, a wedge for determining the position of the block, the wedge having openings therein which are unequally spaced with reference to corresponding openings in the base plate whereby a spike may be inserted through a pair of registering openings, a pair of wedge blocks between the rails to hold them against the aforesaid outer abutments, the wedges having interfitting engagement in a horizontal as well as in a vertical plane, one of the wedges being of a length greater than the width of the base plate whereby a plurality of fine adjustments of the blocks may be obtained to vary the distance between the rails, the other block having a downwardly extending lug projecting into the opening of the base plate between the rail bases whereby the blocks are locked to the base plate and to each other without use of bolts.

TIE PLATE.

1,056,716—A. L. Stanford, Chicago.

A tie plate provided with a shoulder on the top surface thereof extending parallel with the longitudinal dimension of the rail section, a series of merging undulations on the bottom face of the plate parallel with the shoulder, the top surface being cut away upon each side of the center of the rail, a point of mergence of the undulations underlying the center of each of the cut-away portions producing parallel surfaces on the upper and lower edges of the plate at these having flat portions extending a distance sufficient to underlie the points whereby an equal thickness of metal is maintained, the plate remainder of the base of the rail section, a point of mergence of the undulations being positioned in alignment with the ends of the flanges providing an increased thickness and reinforcement for the plate at this point.

1,056,470



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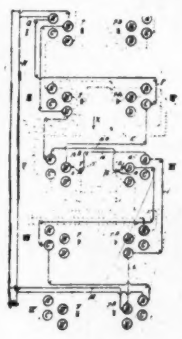

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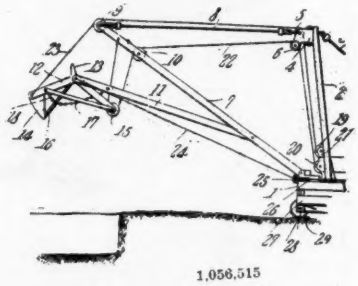

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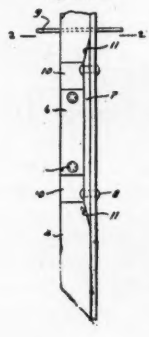

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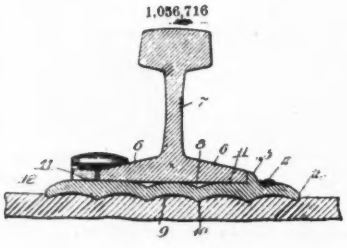

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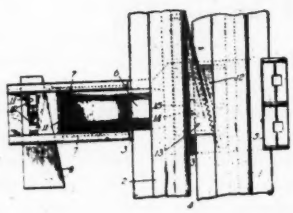
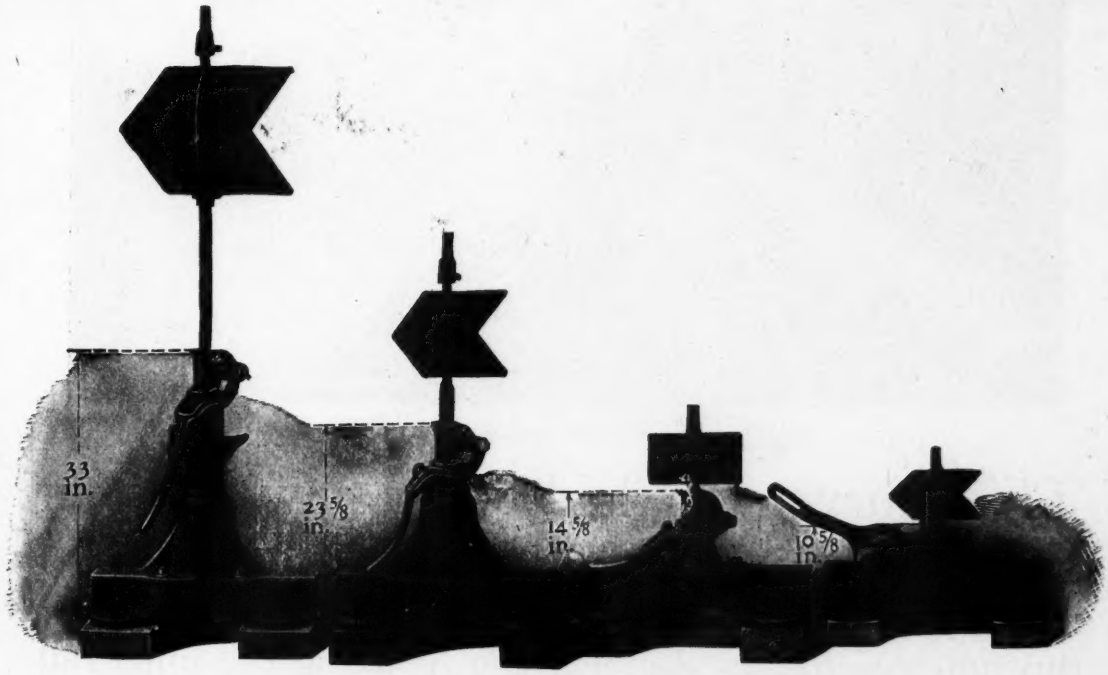


R A M A P O

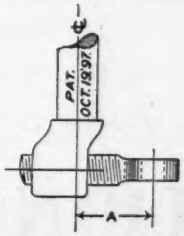


STYLE NO. 17 STYLE NO. 18 STYLE NO. 19 STYLE NO. 20

RAMAPO PATENT SAFETY SWITCH STANDS

1. **POSITIVE THROW.**—Ramapo Safety Switch Stands are rigid for hand operation. The operator raises the handle, thereby releasing the spindle from the automatic mechanism, then throws the switch, but cannot lower the handle or relock switch, unless the points are fully thrown.
2. **AUTOMATIC SAFETY FEATURES.**—A train or car can trail through a switch when set wrong locked with a Ramapo Safety Switch Stand, without breaking the switch points or injuring the switch stand. The first pair of wheels forces the switch points open compressing springs in the switch stand, and when points are half way thrown the springs snap the points the rest of the way. The stand is left locked in new position, just as if thrown by hand and is again ready for either hand or automatic operation.
3. **ADJUSTABLE FEATURES.**—All Ramapo Safety Switch Stands are furnished with adjustable throw and adjustable moving rods, unless otherwise ordered. Adjustable switch rods are not required as either switch point can be adjusted. The throw can always be adjusted to suit that of any switch, one-half turn of the eye bolt crank affecting the throw one-twelfth of an inch. See table of crank adjustments below. The distance of stand from switch can be readily adjusted with the adjustable moving rod without moving the stand on the ties.

CRANK ADJUSTMENTS FOR RAMAPO SAFETY SWITCH STANDS

THROW OF STAND	"A"		THROW OF STAND	"A"
$3\frac{1}{2}$"	$2\frac{15}{16}$"		$4\frac{1}{4}$"	3"
$3\frac{5}{8}$"	$2\frac{9}{16}$"		$4\frac{3}{8}$"	$3\frac{3}{16}$"
$3\frac{3}{4}$"	$2\frac{13}{16}$"		$4\frac{1}{2}$"	$3\frac{5}{16}$"
$3\frac{7}{8}$"	$2\frac{3}{4}$"		$4\frac{5}{8}$"	$3\frac{9}{16}$"
4"	$2\frac{7}{8}$"		$4\frac{3}{4}$"	$3\frac{11}{16}$"
$4\frac{1}{8}$"	$2\frac{15}{16}$"		$4\frac{7}{8}$"	$3\frac{7}{8}$"
$4\frac{1}{4}$"	3"		5"	$3\frac{7}{8}$"

Write for descriptive catalogues on Switch Stands, Switches, Frogs, Guard Rail Clamps, Etc.

Manganese Track Work a Specialty

RAMAPO IRON WORKS

MAIN OFFICE: Hillburn, N. Y. **WORKS: Hillburn, N. Y. and Niagara Falls, N. Y.**

This curve was laid with new rails in February, 1911. The outer rail was flange worn up to December, 1911, about one-quarter inch. At this time *Frictionless* Rail was laid replacing the inner rail of the track; conditions were unpromising because of the amount of wear which had already occurred on the outer rail. But in fourteen months since, there has been no further wear, the track has remained absolutely to gauge without attention, and trains ride noticeably better over the curve.

Frictionless Rail Relieves the Thrust Against the Outside Rail

THE FRICTIONLESS RAIL

F. A. BARBEY, Trustee **S. W. SIMONDS, Treasurer**

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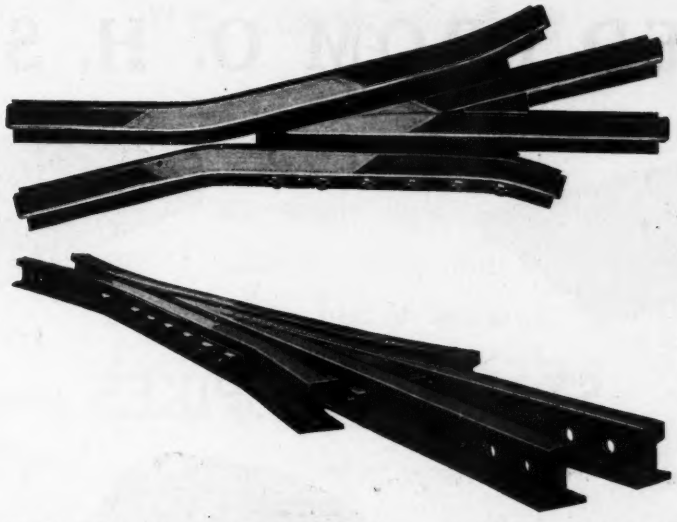

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When you scrap a frog or crossing it is usually due to a wearing out or down of about 10% of the structure at the points of intersection, while the balance is good.

We can *save* you the 90% by reclaiming and restoring the 10%

BY A NEW PROCESS

Let us *show you.*

Send us a frog or crossing—guttered or worn down at intersections.

Either Rail—Manganese Center—or Solid Manganese.

While Indianapolis designs of Solid Manganese Frogs, Frog Crossings and Crossings Revolutionized Maintenance, saving Railroads many Thousand Dollars annually

THIS IS STILL A GREATER ECONOMY

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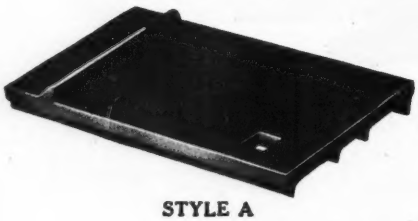
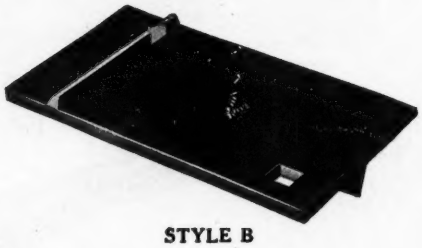


STYLE A



STYLE B

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THE HART STEEL COMPANY

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Plates and Spikes Made by The Elyria Iron & Steel Co.

STYLE O

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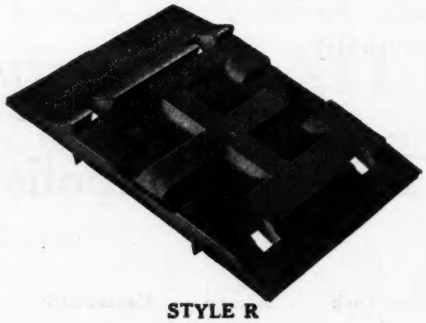
Shows 20 Styles of
Tie Plates



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Franklin Asbestos Smoke Jacks are made lighter than metal smoke jacks, and do not require heavy supports. They are impervious to the action of smoke, gases and water, and are absolutely fire-proof.

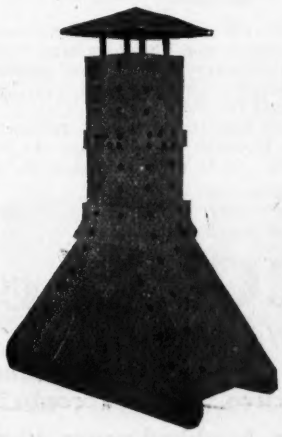
Franklin Asbestos Smoke Jacks are easy to install on a new roof, or in fact on any old roof.

If you are looking for the most durable, and the most economical smoke jack, specify the Franklin Asbestos Smoke Jack and get the additional advantage of light weight.

Asbestos Supplies of Every Description

Asbestos Flat Lumber

Requires no Paint. Never Rusts. Everlasting and fire-proof



Franklin Manufacturing Co., Franklin, Pa.

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(Adopted by 182 American and Foreign Railroads)

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Bowser equipment is recognized as standard all the world over and today its users number over a million, from the small cross-road country storekeeper to the Westinghouse Electric Company, 182 American and foreign railroads, etc.

Home Plant and General Offices, Ft. Wayne, Ind., U. S. A.

$6,483.30 SAVED IN ONE YEAR

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ESTABLISHED 1885.

STORAGE SYSTEMS

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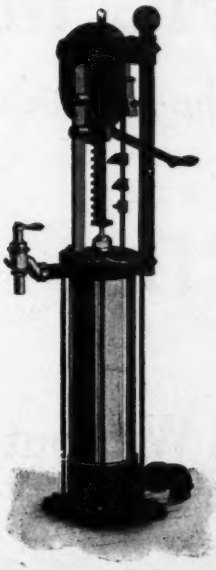
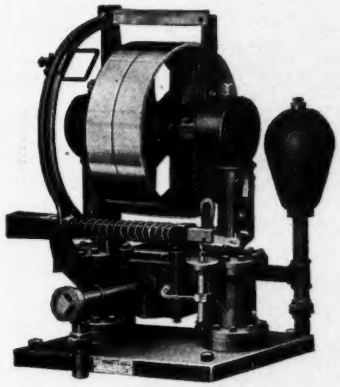
The Bowser Table Pump is especially designed for use in way stations for filling, cleaning and trimming lamps. It is very efficient as the automatic stops accurately fill the container without overflow, thus preventing waste and expediting the work. It is fire-proof, cleanly and a saver of room.



Cut No. 41.

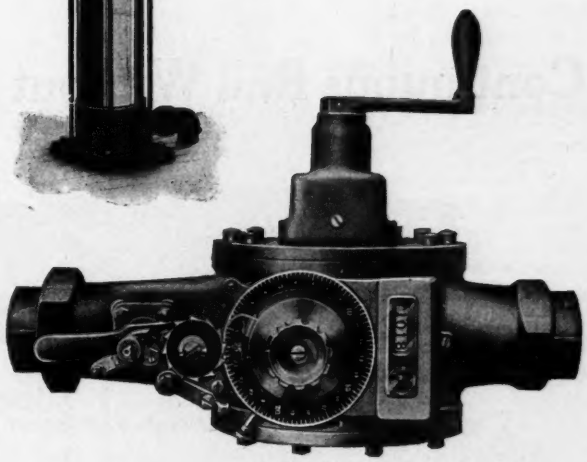
This is the Bowser Standard, Long Distance, Self-Measuring and Recording Hand Pump. It measures gallons, half-gallons, quarts or pints at a stroke and may be used in connection with above or underground tanks.

It is tireless iron clerk that intelligently handles the liquid and never makes a mistake.



Cut. No. 705.

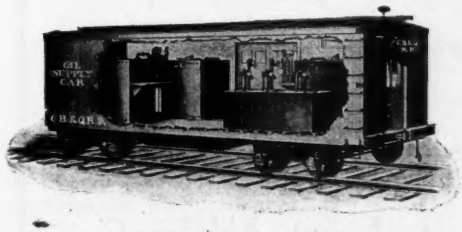
This Double Plunger Power Pump can be either belt or electrically driven. It is especially useful in connection with a Bowser Self-Registering Pipe Line Measure for quickly filling tanks, barrels, transferring oil from tank cars, etc. It is made in several styles to meet the physical needs to be overcome.



Cut No. 751.

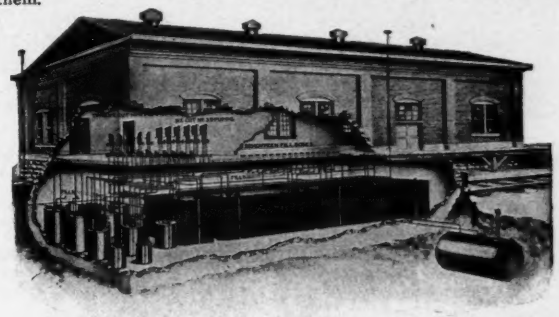
A Bowser Self-Registering Pipe Line Measure enables you to pump liquid from the place you keep it to the spot you need it in exact predetermined quantities by simply turning a valve. It is the ideal method for handling liquids at long range. There are three separate types of measures made:

1st, for simply recording the liquid as it flows through the pipe line; 2nd, for recording and setting for any predetermined quantity; 3rd, this measure does what the other two do, but it is electrically controlled and can be operated at a distance. All measures are designed for use in pipe lines from ½ to 10 inches in diameter. Pump, air or gravity pressure may be used to operate them.



Bowser Oil Supply Car.

The above illustration shows a representative installation as made for the C., B. & Q. R. R. It is one of many such installations among the other roads. It is a highly efficient way for handling expensive and elusive oils. The equipment accurately measures and records every drop of oil used.



A Bowser Oil Supply House.

This illustration shows a representative installation of Bowser equipment in an oil supply house for the Central of Georgia R. R. It is but one of many such installations for the other railroads. We have the unqualified endorsement of every railroad management using our systems. This picture will give you an illustration why.

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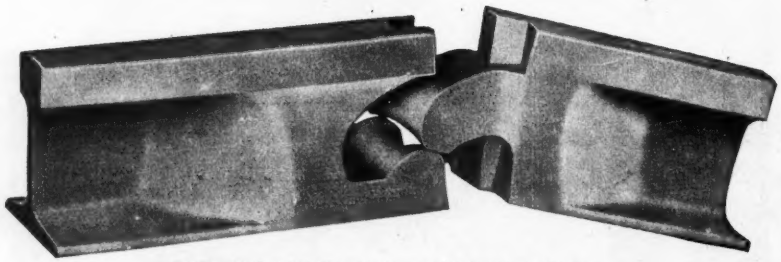
A Continuous Rail Without Angle Bars or Bolts



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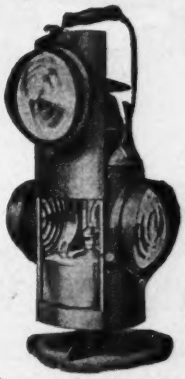

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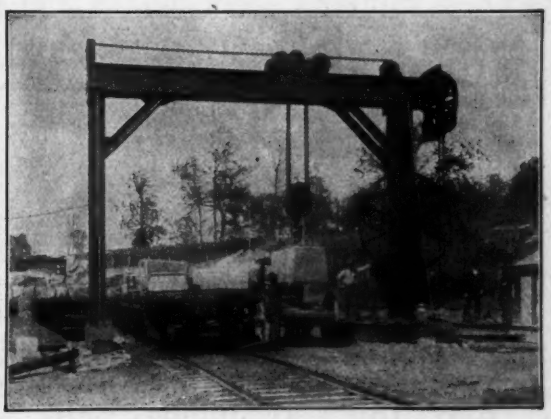

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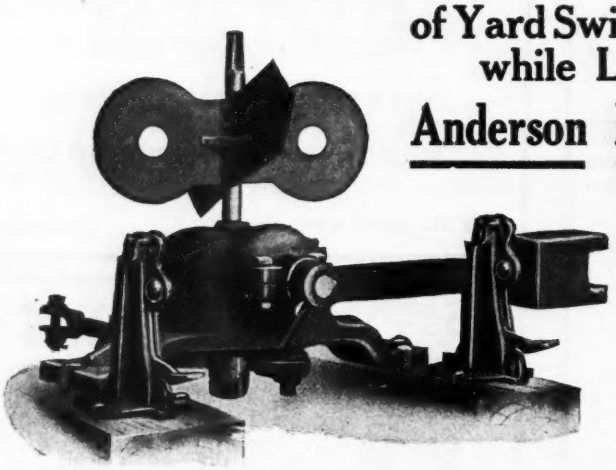
of Yard Switches that are Run Through while Latched if you use the

Anderson Economy Switch Stand



This stand for yard switches, is provided with a special 3 way crank arm made of malleable iron. This 3 way crank arm is designed that when switch is run through, one of the arms to which the switch is connected will shear off, without damage, to any part of the switch mechanism.

The switch can be quickly placed in order by connecting the rod to one of the other arms. When the three arms are destroyed a new three way crank can be applied. These are furnished at 50 cents each. This feature is not new.

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Nonbreakable cranks are furnished for main line switches.

Full Details and Description of This Switch Stand in Our Catalogue. Write for It

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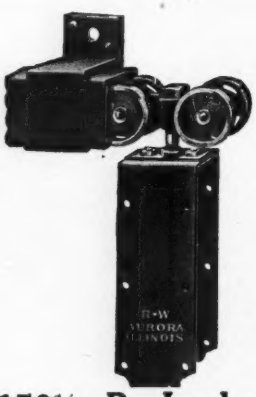

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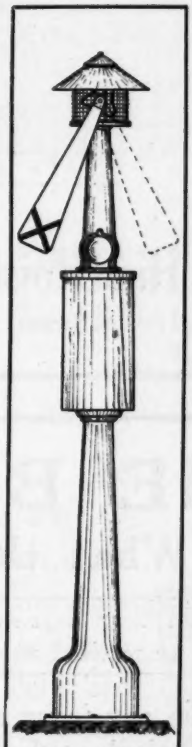

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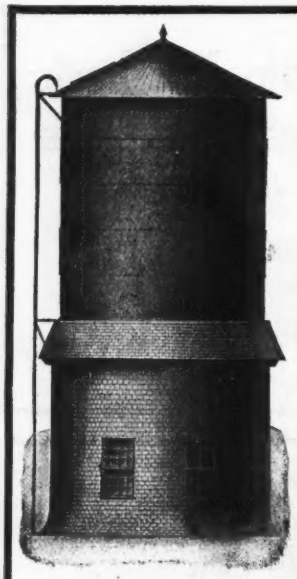

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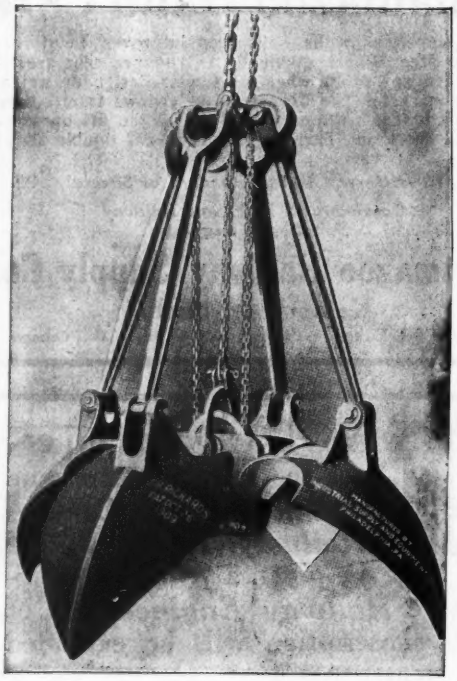

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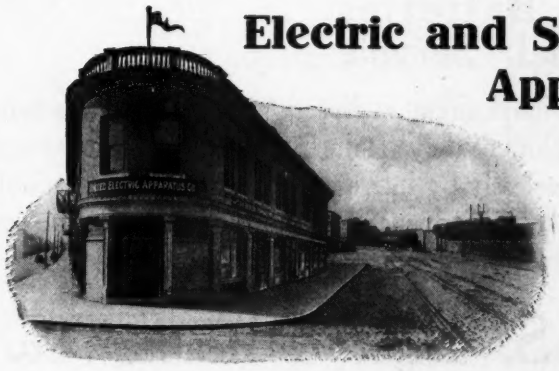

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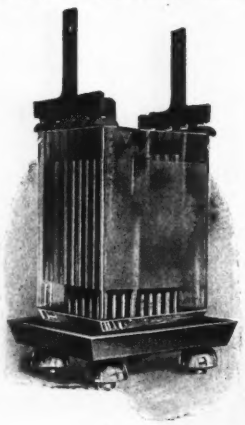

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Indianapolis Switch & Frog Co., Springfield, O.
Ramapo Iron Works, Hillburn, N. Y.
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Verona Tool Works, Pittsburg, Pa.
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Track Necessities Co., Chicago.
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Electric Ry. & Equip. Co., Cincinnati, O.

Turntable Tractors.
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Dixon, Joseph, Crucible Co., Jersey City, N. J.

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Kalamazoo Railway Supply Co., Kalamazoo, Mich.

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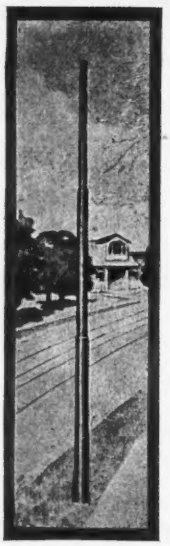

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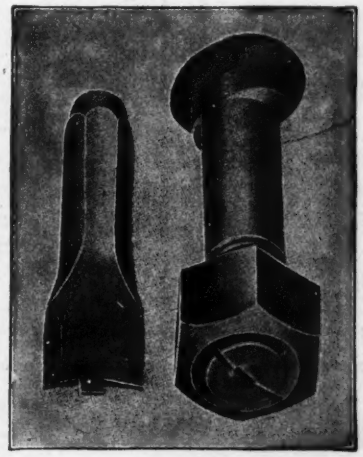

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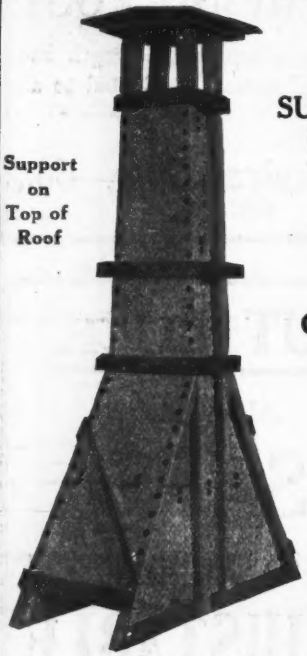

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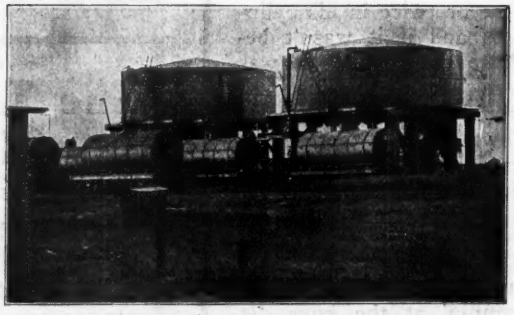

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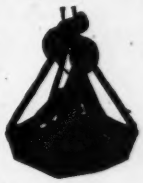

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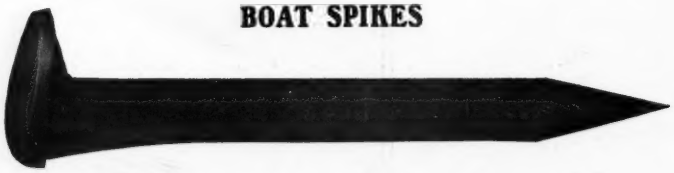

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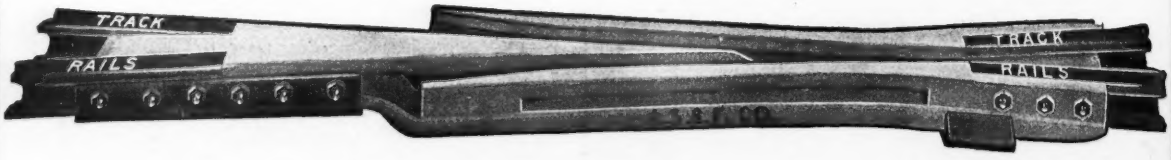

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